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Different Ways of Fitting a Key.

BY JOHN RANDOL.

The steam engine building machinists have an idea, perhaps it would not be too much to say a long established and firmly founded conviction, that they themselves are the only real, simon-pure, bona fide machinists in existence, and that all the other machine workers are mere interlopers, specialists, skilled laborers, "one thing hands," not really "machinists" at all.

This belief came in undoubtedly, when steam engine manufacture came in, and the steam engine was regarded as the miracle it is, and when the millwrights and blacksmiths, who preceded that class of mechanics now called "machinists" here and known as "engineers" on the other side, first found that steam was hot, and could squeeze through a little hole, and "steam fits" were considered high grade workmanship, and a knowledge of the slide valve and the workings of the high pressure engine was held to be way up among the eternal mysteries, as again, in fact it is, since it is as far as we have gone towards the production of power in quantities to suit at a cost which we can afford to pay. As steam engine building became more in demand, the brightest and most skillful mechanics naturally became builders of steam engines of one form or another, and so the craft grew in numbers, skill and importance and in its own estimation; and although Corliss engines in large sizes can be bought to-day for 3¼ cents per pound, the steam engine builders still cling to the belief of other days, and insist on the honor of first place among iron-workers.

And they are really not so far out of the way after all. They are far from having the best shops, or the best tools, or the best management of any iron working establishments, and many of the old steam engine building shops of high repute are either closed or are making a mere show of running on what jobbing they can pick up, but the engine builder's men are mostly all round machinists, and can do a job with or without tools, as the case may demand.

The new wheel had been pounded home on the shaft of the little steamer with a battering ram, and the pattern for the key had been whittled with a jack-knife and smoothed with a new coarse file to fit, and the boy had gone to the shop for the key forging, and the boss of the job thought he would have the key driven in the wheel and the boat out of the dry dock in about an hour. The wheel hub was about 11 inches long, and I had an idea that the smith was an old timer who would send up a forging that would just about drive home when it had had a couple of rubs of the file on each side, if the boat was to swim as soon as the key-fitter said it would.

Perhaps some of our inland machinists would have to think twice to be sure what shape the key ought to be to pass the stern-post and drive out when the shaft bearing covered the keyway in the wheel hubs, but of course it was an every-day matter with these men, and the key came back, yet warm from the forge, in the shape shown in Fig. 1. The key itself was only a little piece of the forging the boy brought down to dry-dock. The remainder was an offset porter-bar, with a good, substantial gib-end for driving out, and the offset was enough to pass the stern-post. The key was relieved in the middle for about a third of its length, and was by no means so smooth as I expected to see it.

First the boss key fitter, who had a brand new 14-inch bastard file, a hammer and flat chisel, and a light sledge, but no vise, set outside callipers to the width of the keyway, probably not more than half a 64th out of the way. Then the helper

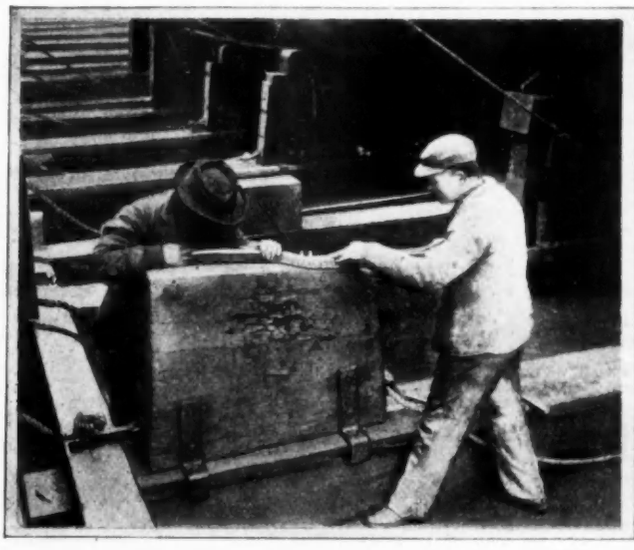

Fig. 2. THE FITTING PROCESS.

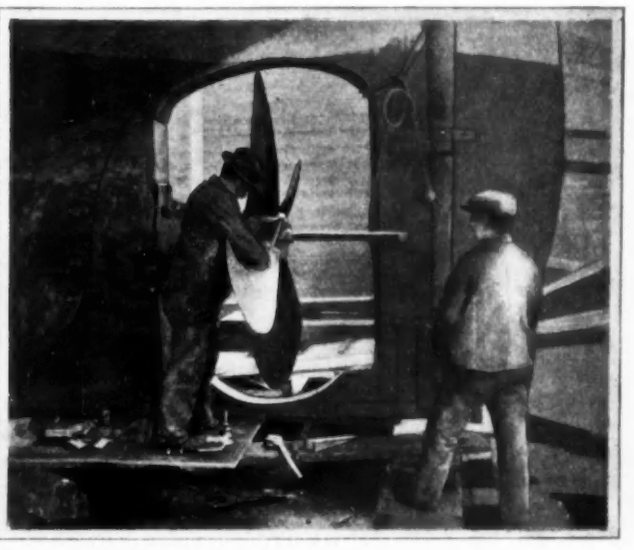

Fig. 3. THE DRIVING HOME.

held the key on a big block of wood screwed to the deck of the floating dock, while the boss fitter filed the point of the key to what he guessed was about right by the callipers, and the key was pounded into the keyway as far as it would go, and then pounded out again, bearing good marks of the keyway size, and the fitter set his callipers over again to these marks, slid them along on the key

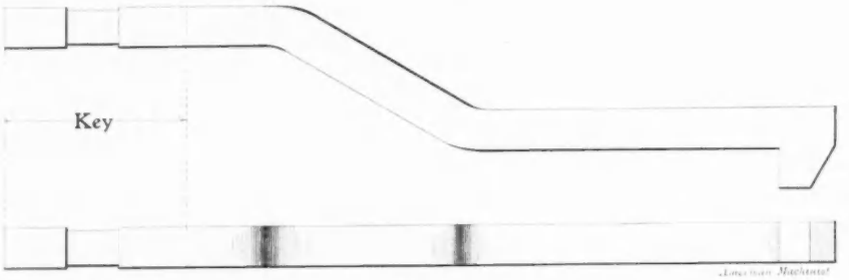

Fig. 1

forging (which was nowhere near to size), and said the blacksmith didn't seem to take much notice of his sizes lately. Fig. 2 shows how the helper held the key on the block, both for chipping and filing, as the fitter took a chip with a chisel off all of one side of the key, and filed it smooth, which did not take long, as his chipping was smooth and the file was new. The key was tried once in the keyway, driven out again, the marks, which were not so numerous as to cover the key surface, were callipered once more, and to this setting of the callipers the key was finished by the rough file, until the boss fitter said he guessed it would go in, and it did, the boy driving it home with the sledge. It went about right, a little way every blow, and did not drive much harder at last than at first. The engineer of the boat, who watched the driving, said it was a good fit. When it was driven up to the mark the helper marked it round with the chisel, close up to the wheel hub, as in Fig. 3, and the porter-bar was broken off with the sledge; the break was smoothed over with the file, the shaft nut was screwed on, and we were afloat inside of the hour.

When I think of the tool-room procedure, the milling or shaping, the trials with a square and the smooth filing which would have been put on that key had it been fitted by "the best methods known in the trade," it seems very clear that there is more than one way to skin a cat.

I really don't think myself that the key touched all over on two sides after it was driven, and I have a haunting suspicion that it was bigger at the point than anywhere else, and that the boss key fitter knew pretty well what he was about. But I don't think the wheel will work loose, and I do think the key was fitted, chipped and filed, without a vise, in quick time, quicker by at least one hour than if a toolmaker had done the work, and if it was done well enough what fault can be found with the job?

Of course, the tool-maker will say the job was a botch, and, of course, the boss key fitter who did the job would, if he saw the tool-maker fit a key, say: "Oh, yes, he's making a white-shirt job—can't do nothin' without a shop full of tools." Both these good mechanics, the toolmaker and the boss key fitter, are right in their views, but they would not change places to anyone's satisfaction, and of the two I really think the boss key fitter was the more skillful man, though not the better tool-user, and that he has at least as good a claim to the honorable title of "machinist" as the tool-maker has.

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A United States patent was issued on April 6th for "an apparatus for generating and distributing music electrically," embracing 175 claims, occupying nearly eleven pages of the "Patent Office Gazette."

Gear-Testing Machines.

We illustrate herewith three gear-testing machines in use at the works of the Brown & Sharpe Manufacturing Company, the purpose of which is to determine if the gears are correct as soon as they are cut, instead of waiting until they are sent to the assembling department with the result of annoyance and delays in case the gears do not mesh properly when put in place. This system of testing also puts a check upon the workman by detecting faults before the identity of their author has been lost, and in the case of a large lot of duplicate gears it serves the purpose of gaging the gears from time to time and knowing that they are correct, thus making it impossible to accumulate a lot of gears before an eror in the setting of the gear cutter has been detected.

The machines are provided with a set of standard arbors and bushings for the different sizes of hub holes, which are so mounted that the gears can be adjusted to properly mesh together, when suitably mounted scales with verniers enable the center distance to be read off, or the arbors may be first set to the correct center distance and the gears be then put in place and tested for accuracy. The machines are in constant use in the gear department, being used by both workmen and inspectors.

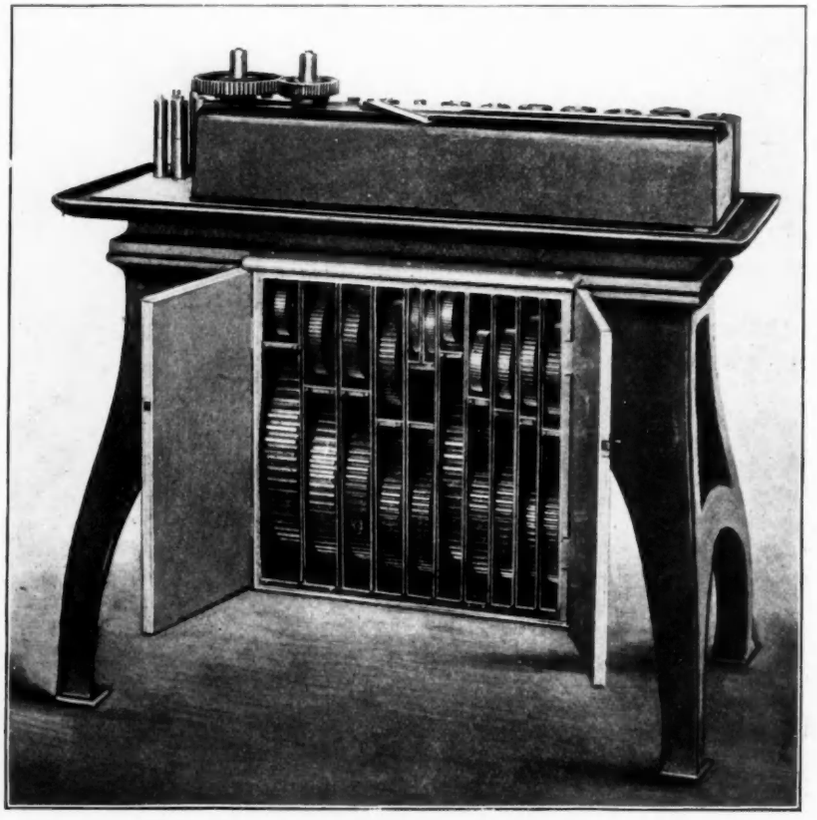

Fig. 1. TESTING SPUR GEARS.

The spur gear testing machine, Fig. 1, consists of a bed with an arbor located in it at a fixed point, and one in a slide which can be moved to give the required

center distance for the gears to be tested. These gears are mounted on the arbors, being fitted to them by means of bushings selected from the set shown back of the bed. The slide is moved until the gears mesh properly and is then clamped in position by means of the lever shown. The gears are turned by hand, to see that they run true and that the teeth have a bearing the full width of their faces. If only one gear of a pair is to be tested it is run with a gear of the same pitch selected from the gears shown in the case below the table. The scale and vernier on bed and slide already mentioned, test the center distance.

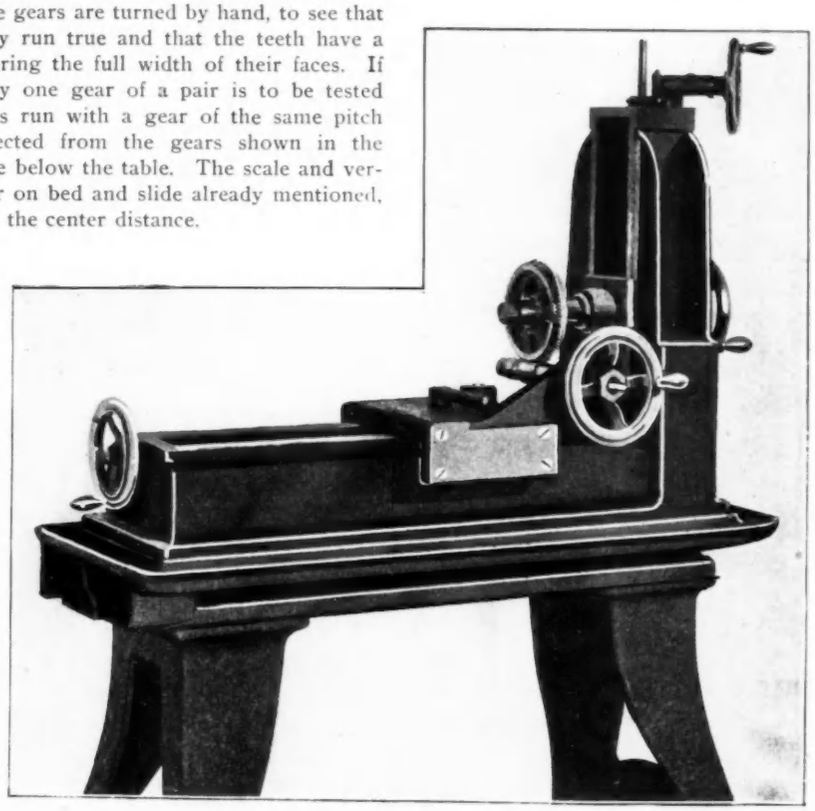

Fig. 2. TESTING WORM GEARS.

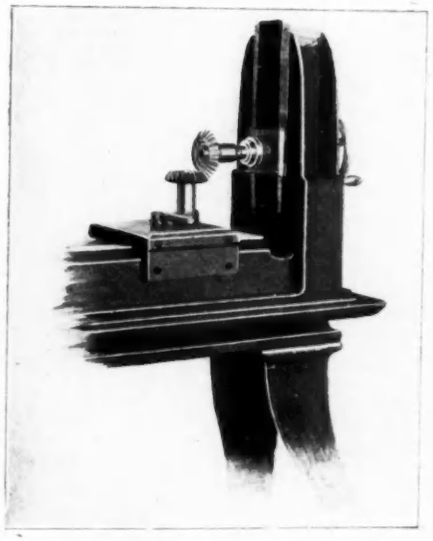

Fig. 3. TESTING BEVEL GEARS.

The machine shown in Figs. 2 and 3 is shown arranged for testing bevel gears and worms and worm wheels. In this case there are two slides, one on the bed adjusted by means of a screw with a half-nut that can be readily disengaged by means of the lever shown, so that the slide may be quickly moved by hand; the other on the upright, also adjusted by means of a screw. It will be noticed that when testing bevel gears, the bracket and hand-wheel used for worms can be removed. When bevel gears with short hubs are tested the slides can be brought nearer together than shown in Fig. 3, making less overhang. Spiral gears may also be tested with the machine arranged as for worm and wheel.

Fig. 4 represents a large machine for testing spur and bevel gears. The two heads carrying the gears in this illustration are made to swivel, so as to test bevel gears whose axes are not at right angles. Graduated arcs reading to degrees facilitate the setting to the required angles. This machine is arranged so that it may be driven by power. The lever shown on the head, at the right, is for accurately adjusting the center distance when testing spur gears in a manner made familiar by vernier calipers.

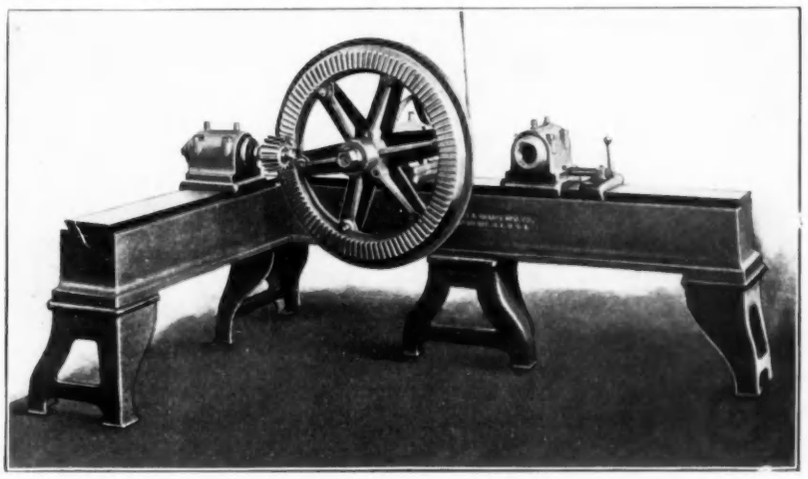

Fig. 4. MACHINE FOR LARGE SPUR AND BEVEL GEARS.

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Gear Arm Proportions.

BY HENRY HESS.

There are probably few simple details of as general use as gear arms, in which there is a greater variation of size, under similar conditions. The text-books give various formulæ, generally quite arbitrary; some, it is true, base the proportions on the strength of the gear teeth; and this is rational because as the load must be carried by the teeth, the arms need not be stronger and certainly should not be weaker than the teeth. Unfortunately, however, the methods of determining the strength of gear teeth are anything but correct, different authorities varying enormously in their results. At least this was so until quite recently, or up to the time Mr. Lewis brought out his method of calculating gear teeth; see "American Machinist" of May 4 and June 22, 1893, and February 18, 1897.

In deducing a formula for gear arms, it is assumed that the thickness of the rim is sufficient to distribute the load between the arms; this assumption is quite justified, as such a depth is necessary to prevent bending of the rim between adjacent arms. By equating the expressions for the tooth strength and that of a beam supported at one end and loaded at the other, the general expression arrived at is

$$Z = \frac{C^3 R (N-7)}{50 A} \text{ for circular pitch, and}$$

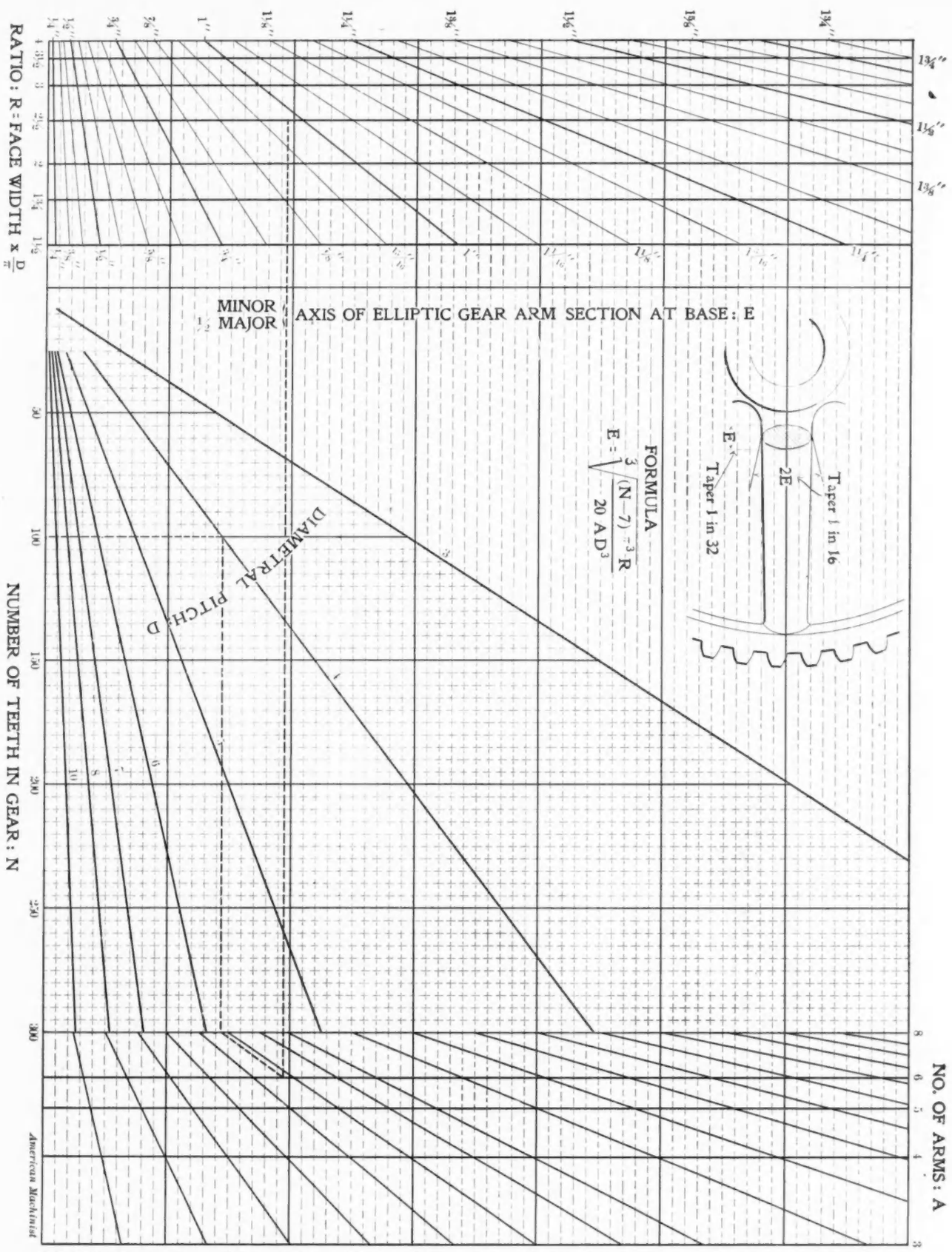
$$Z = \frac{\pi^3 R (N-7)}{50 D^3 A} \text{ for diametral pitch,}$$

when

Z = modulus resistance of arm cross-section;

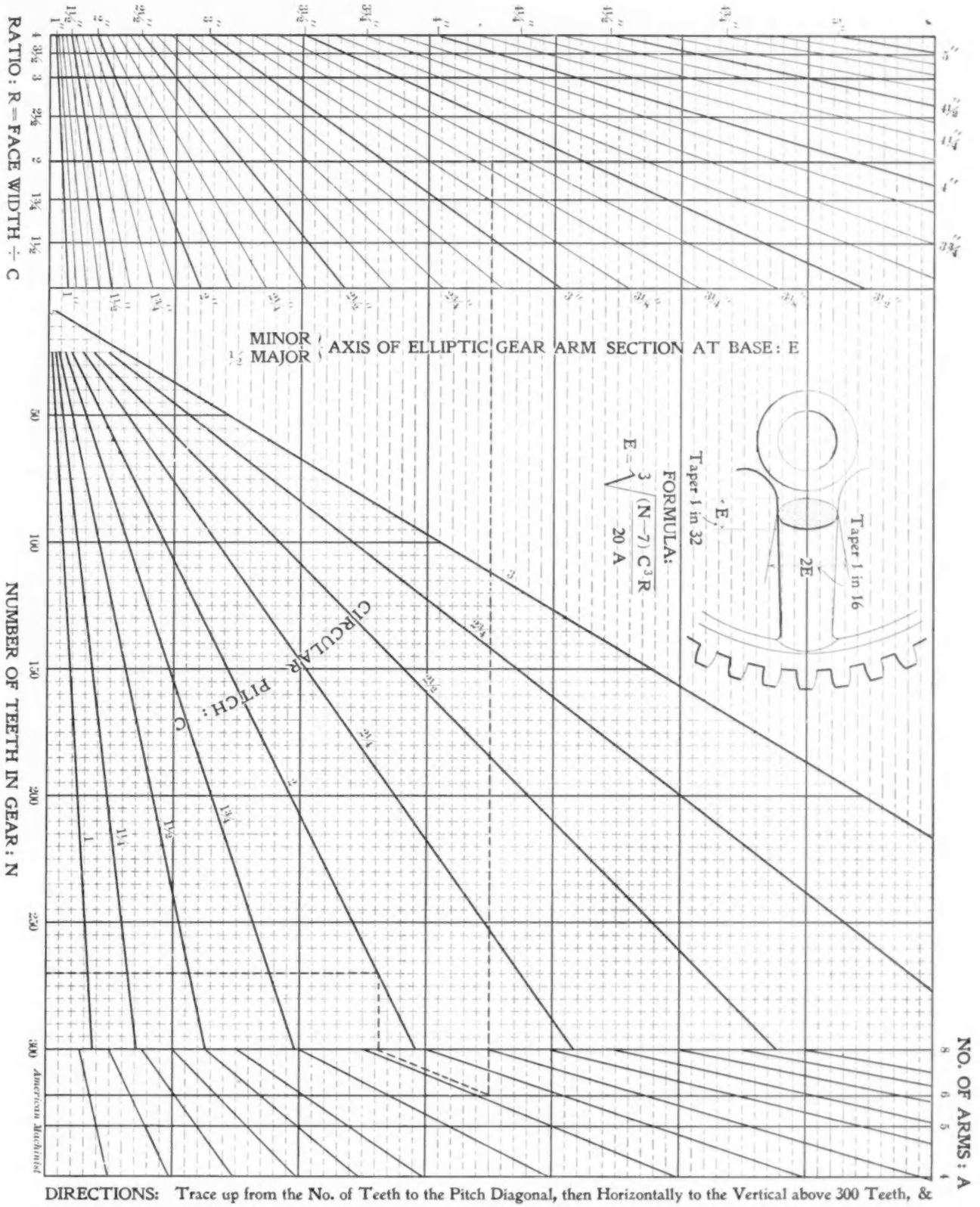
C = circular pitch;

D = diametral pitch;


RATIO: R = FACE WIDTH x D/π
NUMBER OF TEETH IN GEAR: N
NO. OF ARMS: A
MINOR / MAJOR AXIS OF ELLIPTIC GEAR ARM SECTION AT BASE: E
DIAMETRAL PITCH: D
FORMULA
E = ∛((N − 7) ÷ 3 R / 20 A D³)
E
Taper 1 in 32
2E
Taper 1 in 16
American Machinist

DIRECTIONS: Trace up from the No. of Teeth to the Pitch Diagonal, then Horizontally to the Vertical above 300 Teeth, then Parallel with the Nearest Diagonal to the Vertical Headed with the Arm No. "E"; then Trace to the left Horizontally to the Vertical "R" representing the Ratio of Face Width to Circ. Pitch, "R". Take the Nearest Diagonal as the Arm Base Thickness "E"

PROPORTIONS OF GEAR ARMS FROM DIAMETRAL PITCH.


RATIO: R = FACE WIDTH ÷ C
NUMBER OF TEETH IN GEAR: N
NO. OF ARMS: A
MINOR / MAJOR AXIS OF ELLIPTIC GEAR ARM SECTION AT BASE: E
FORMULA: E = ∛((N−7) C³ R / 20 A)
Taper 1 in 32
Taper 1 in 16
E
2E
CIRCULAR PITCH: C
American Machinist

DIRECTIONS: Trace up from the No. of Teeth to the Pitch Diagonal, then Horizontally to the Vertical above 300 Teeth, & Trace Parallel to the Nearest Diagonal to the Vertical Headed with No. of Arms; then Trace to the left Horizontally to the Vertical "R" representing the Ratio of Face Width to Circ. Pitch. Take Nearest Diagonal as Base Thickness of Arm "E".

PROPORTIONS OF GEAR ARMS FROM CIRCULAR PITCH.

R = ratio of face-width to circular pitch $= \frac{F}{C}$;
F = face width;
N = number of gear teeth;
A = number of arms.

If it is preferred to use the face-width itself, instead of its ratio to the circular pitch, then

$$Z = \frac{C^2 F(N-7)}{50 A} \text{ for circular pitch;}$$

$$Z = \frac{F(N-7)}{50 D^2 A} \text{ for diametral pitch.}$$

By these formulæ the dimensions of a gear arm of any section whatever can be determined.

As by far the great majority of cast gear

arms are of elliptical cross-section, these expressions are reduced by inserting the terms of the modulus of resistance of an ellipse in which the major axis is double the minor, and the formulæ become, when

E = the thickness of the arm at its base, and
$2E$ = the width of the arm at its base;

$$E = \sqrt{\frac{(N-7)\,C^3 R}{20\,A}} = \sqrt[3]{\frac{(N-7)\,C^2 F}{20\,A}} \left\{ \text{for circular pitch.} \right.$$

$$E = \sqrt[3]{\frac{(N-7)\,\pi^3 R}{20\,A\,D^3}} = \sqrt[3]{\frac{(N-7)\,\pi^2 F}{20\,A\,D^2}} \left\{ \text{for diametral pitch.} \right.$$

To reduce the labor involved by the mathematical solution, the diagrams have been constructed, one for diametral pitches ranging from 10 to 3, and the other for circular pitches ranging from 1 to 3 inches; as 3 diametrical pitch is very nearly equal to 1-inch circular pitch, the second diagram extends the range of the first without a break, so that, between the two, any case likely to arise will be taken care of. Diametral pitch is given in the first diagram, as the more general practice uses that for small and medium-sized gears, while for large work, circular pitch is generally employed, and is therefore used as the basis of the second diagram. Two diagrams are required, as the inclination of the pitch diagonals toward the end values would become too slight to admit of accurate reading on a single one.

By tracing the number of teeth from the bottom scale to the pitch diagonal in the main portion of the circular pitch diagram and referring the intersection to the vertical scale under 8, the value is found of

$$\frac{(N-7)\,C^3}{20\,A} \text{ for } A = 8 \text{ arms};$$

for any other number of arms this is modified by employing the auxiliary portion of the diagram at the right, referring the value just found along or between the nearest slant lines to intersection with that vertical representing the number of arms actually used. By now tracing this hight horizontally to the left to that vertical R representing the particular ratio of face-width to circular pitch employed, and taking a reading from the nearest slant line crossing this vertical, the value first found is multiplied by R and the cube root extracted.

Usual practice gives a face-width between two and three times the circular pitch, but other proportions are occasionally met with, and therefore ratios from 1½ to 4 are given.

Concise directions are printed on the diagrams. Dotted trace lines of the following examples are also drawn in:

Ex. 1.—Given a gear of 100 teeth, 4 diametral pitch, 6 arms and ratio of face width to circular pitch = 2½.

Trace 100 teeth up to diagonal for 4 pitch, horizontally to number of arms 8, slantwise up to number of arms 6, horizontally to the left to ratio 2½, which is intersected between 15-16″ and 1″; therefore thickness of arm is to be taken as 1″ and width as 2″. By calculation the dimensions are 0.″96 and 1.″98.

Ex. 2.—Given a gear of 270 teeth, 2″ circular pitch, 6 arms and ratio of face-width to circular pitch = 2.

Trace as before and find 3¼″ full as thickness of gear arm at base, and 6½″ full as width. The calculated dimensions 3.″27 and 6.″54 agree almost absolutely with the much more quickly obtained values by diagram.

In large arms the designer will frequently prefer a cored section. A satisfactory one will be that of Fig. 1, in which major and minor axis of both core and arm are relatively as 2 to 1. By equating the moduli of resistance for solid and hollow elliptical sections of these proportions, it is found that

$$E^3 = \frac{D^4 - d^4}{D}, \text{ in which}$$

E is the thickness of the solid arm as obtained by diagram or formula;
d and D are dimensions of the cored arm.
(See Figs. 1 and 2.)

In order to lessen the work of making the core-box by substituting flat surfaces for curved ones, an approximation like Fig. 2 will add but slightly to the weight, as is shown by the ellipse dotted in for comparison.

The ellipse outlines are formed of circular arcs struck from four centers, which will approximate very closely to the true ellipse. The construction of the core sides is readily apparent from the sketch.

The arm taper is stated as 1 in 32 and 16, respectively, for the arm thickness and width; this gives a pleasing appearance for a moderately long arm; but it is not a hard-and-fast rule, as a greater or lesser taper may be employed to suit the designer's fancy without affecting the strength of the arm, unless the taper is made so excessive as to bring the dimensions at the rim down to one half of these at the base.

Arms have been proportioned by this method at the Niles Tool Works, for a very wide range of sizes with satisfactory results on lathe change gears and heavy plate-roll driving gears.

As the tooth and arm are of the same material, the method is satisfactory for all cast gears, but this must not be interpreted to mean that this or any other formula will prevent shrinkage strain due to relatively large hubs or very heavy rims; where these occur, great care must be excercised in the foundry and it will also not be amiss to add a generous amount of metal to the arms.

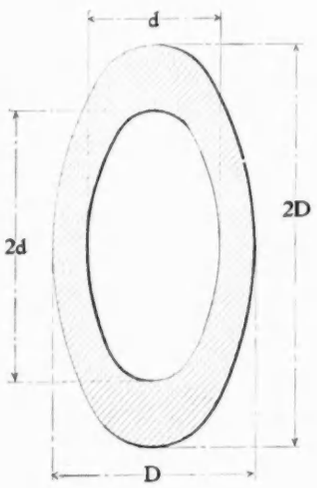


Fig. 1

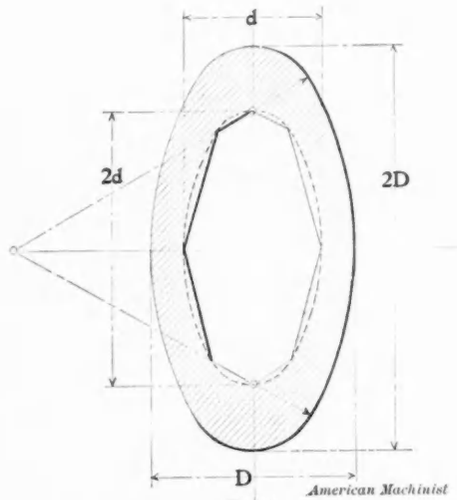


Fig. 2

PROPORTIONS OF HOLLOW ARMS.

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The year 1896 seems to have been unusually prolific of loudly and widely advertised, but unusually visionary and worthless mechanical "inventions." The "Engineering News" devotes two or three columns to the enumeration of a score or more which attained national notoriety. The greatest fake of the year was the Brambel Sleepy Eye rotary engine. The Chaquette merry-go-round air compressor, of Bridgeport, Conn., the home of the Barnum-Bailey show, would have made a notable addition to the attractions of the "greatest show on earth," only that it would be impossible to transport it. A great amount of money has been spent in developing this wonder, and we are informed that it is not dead yet. The "Engineering News" failed to include in its collection the Bazin roller steamship. It was probably not included because it was not an American affair, and because, also, it lapped over so far into the present year. It, however, has all the other qualifications for inclusion in the category of absurdities. It has lately been tried in France, and it is a pronounced failure. It is now undergoing various "improvements."

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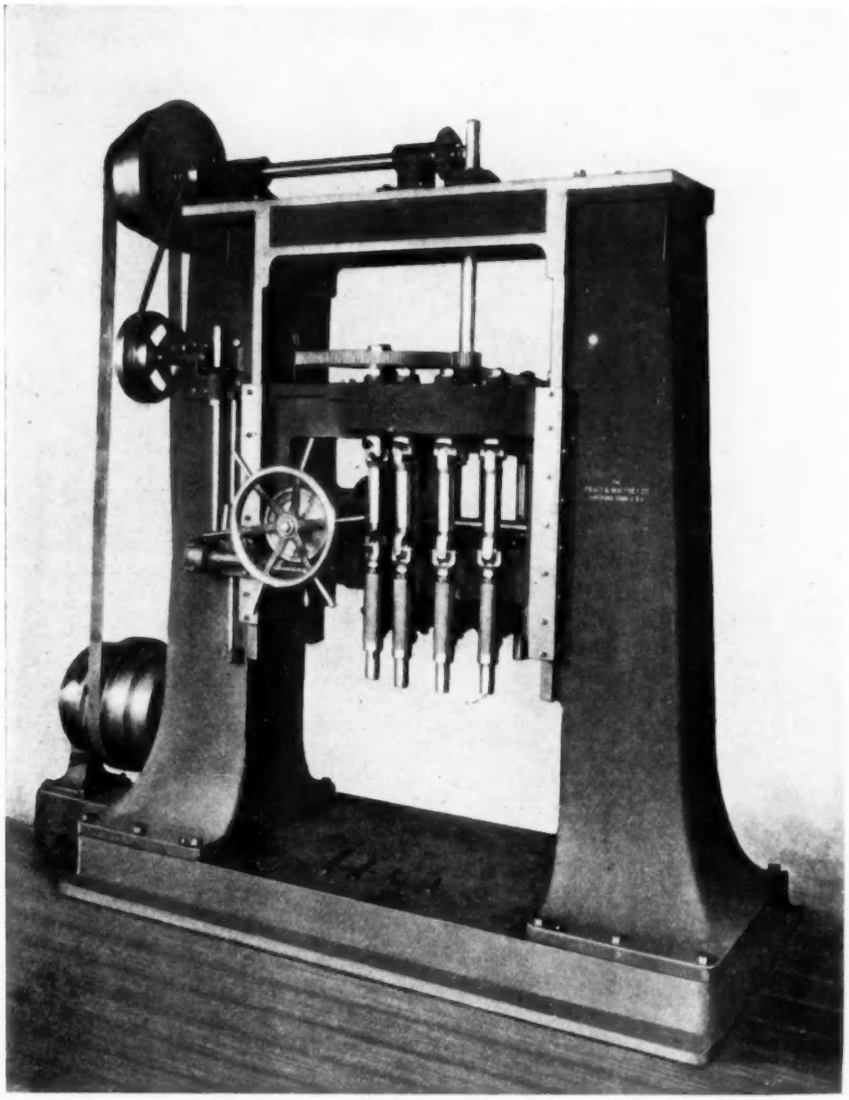
When steam becomes visible it ceases to be steam. The exhaust seen coming from an engine consists of particles of liquid water mixed with air which is gradually absorbing it.

Multiple-Spindle Drilling Machine for Heavy Work.

We give herewith an illustration of a large-size multiple-spindle drilling machine which was designed specially for drilling eight holes simultaneously in the frames of electric motors for railway purposes. These are of steel, and the machine is designed to drill holes up to 1 5-16 inches diameter in that material.

In these days the conditions of manufacturing are such that one can seldom afford to drill only one hole at a time where more can be done, and this machine is typical of a line of similar machines, the smaller ones being kept in stock, though machines of the size and weight illustrated are usually built to order.



MULTIPLE-SPINDLE DRILLING MACHINE.

As will be perceived, the machine consists of a bed plate on which stand two substantial uprights, the inner faces of which form guides to which is fitted the carriage which carries the drill spindles and the driving and feeding mechanism; all of which will be readily understood from the engraving. The carriage is counterbalanced by weights within the columns, is fed automatically or by hand as may be desired, and has an automatic stop for the feed motion. It will be noticed that the reduction of speed by gearing is very considerable, so that the vertical splined shaft and the bevel gears above run at relatively high speed. The spindles are all driven from a central gear wheel, and by means of universal couplings, the drill spindles proper can be driven when set in any required position; which setting is provided for by means of adjustable arms clamped to the under side of the carriage, the outer ends of these arms constituting the bearings for spindles. The spindles are made to take the No. 4 Morse taper shanks, and have ball-bearing thrust collars. They have an independent vertical adjustment of 4 inches to compensate for different lengths of drills, or to enable drilling to be done at different levels if desired. This adjustment is operated by a rack and pinion, and the spindle sleeves are securely clamped after adjustment. The vertical travel of carriage or head is 24 inches, and the distance between the front and the rear spindle may be from 24 to 40 inches. The least distance between any two spindles in this particular machine is 4¾ inches. Similar machines are being constructed by the builders (Pratt & Whitney, Hartford, Conn.) to drill from two to twenty-eight holes simultaneously. The weight of the machine illustrated is about 28,000 pounds.

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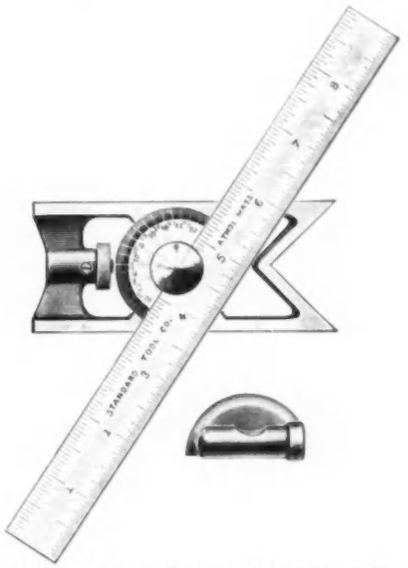
Bellows' Combination Square and Protractor.

The cut shows a new combination square, level and protractor made by the Standard Tool Company, Athol, Mass. It requires no explanation. The central disk is graduated, and the blade may be set at any desired angle and clamped by a screw at the back. The blade also clamps into the left hand end, making a perfect square. The V in the right hand end is a right angle, and may be applied to the corner of a planer platen or any similar place. The little level shown below also clamps to the disk at the center, and may be adjusted to any angle.



COMBINATION SQUARE, LEVEL AND PROTRACTOR.

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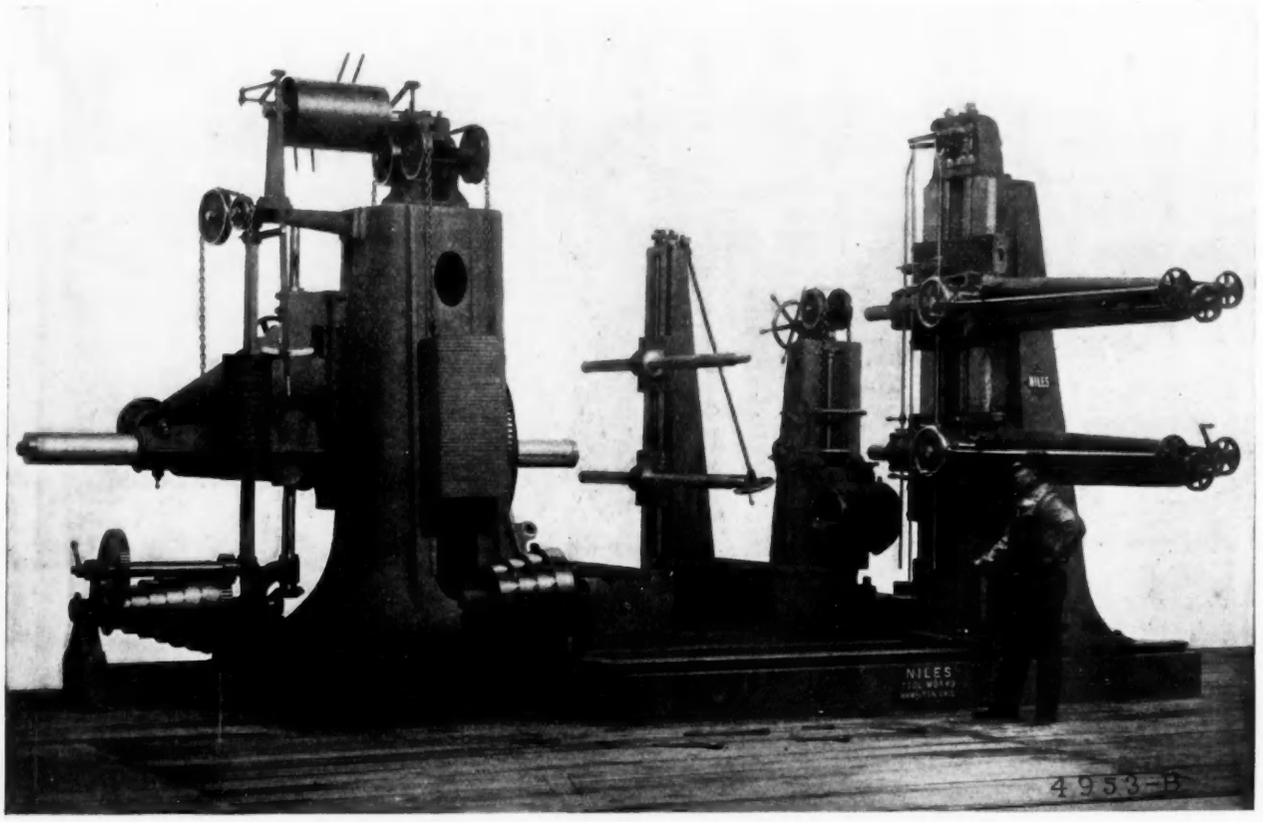
Chas. Churchill & Co., of London, Eng., importers of American machine tools, report such a growth of their business as to necessitate the reorganization of the company with an increase of the capital stock to 50,000 pounds sterling. Of this 30,000 pounds has been subscribed for in fully paid cash shares, and 10,000 pounds has been allotted as good will for the old business, leaving 10,000 pounds for further issue when required. The bearing of this action on the prospects for trade abroad in American-made tools is highly significant.

Large Cylinder-Boring Machine.

We give two views of an interesting machine tool for boring the cylinders and valve seats of Corliss engines. It is arranged also for miscellaneous boring and facing. The machine is provided with two bars, one 14 inches and one 7 inches diameter. Each of these is fitted with a sliding head. The feed to the sliding head is obtained through the low column shown at the left hand of front view of machine; this column is put in for that purpose; the construction of the saddle and main spindle for the purpose of miscellaneous boring preventing the application of the feed to the saddle.

bore and two ports simultaneously of cylinders of the above specifications, and covering a range of diameters from 14 to 60 inches; and it is adapted to bore the main bore and one port simultaneously of cylinders from 12 to 14 inches diameter. It is also arranged to face, counterbore and turn the flanges of frames. The machine weighs, approximately, 110,000 pounds.

Unfortunately the front view is somewhat obstructed by posts which support a line of shafting, but a good general idea of the tool is given by the engravings. It was built by the Niles Tool Works, Hamilton, O.



A LARGE CYLINDER-BORING MACHINE.

The traverse of the 7-inch bar is 8 feet, this being measured from the point of the tool on the facing head next the main column. The maximum distance from the point of tool on facing head next the column to the outboard bearing is 10 feet. The main spindle is 8 inches diameter, and has 60 inches traverse, with a sliding bar to bore 60 inches. The machine is furnished with one pair of port-boring bars to bore 5 inches diameter. The maximum distance from the top of the table to the center of the upper boring spindle is 7 feet 4 inches. The table is so arranged that the upper facing head, or the one furthest from the main column, will clear the outer edge of the table in boring smaller cylinders.

The machine is adapted to bore the main

Some Barriers to Progress in Machine Design.

BY CHARLES HOTCHKISS.

There has been much written about machine design, but very little about designers and their relations to the business and the office of the work in which they may be engaged as employés or partners.

I will give expression to a few thoughts that come to me, bearing upon this matter, after many years of experience as machinist, designer and engineer.

First, I will say to the young man ambitious to become an engineer, by all means aim to get at the head of your business, but if experience counts for anything there is much you must learn beside the laws governing machine designing before you can succeed, and chief of all you must learn the laws governing your employers or partners, who may not be experienced as designers, draftsmen or engineers.

Get experience first, then learn to manage your superiors; with both these you will succeed, let either one be lacking and you will fail unless you are so fortunate as to be associated with men, who, from their own experience, have learned to put themselves in your place.

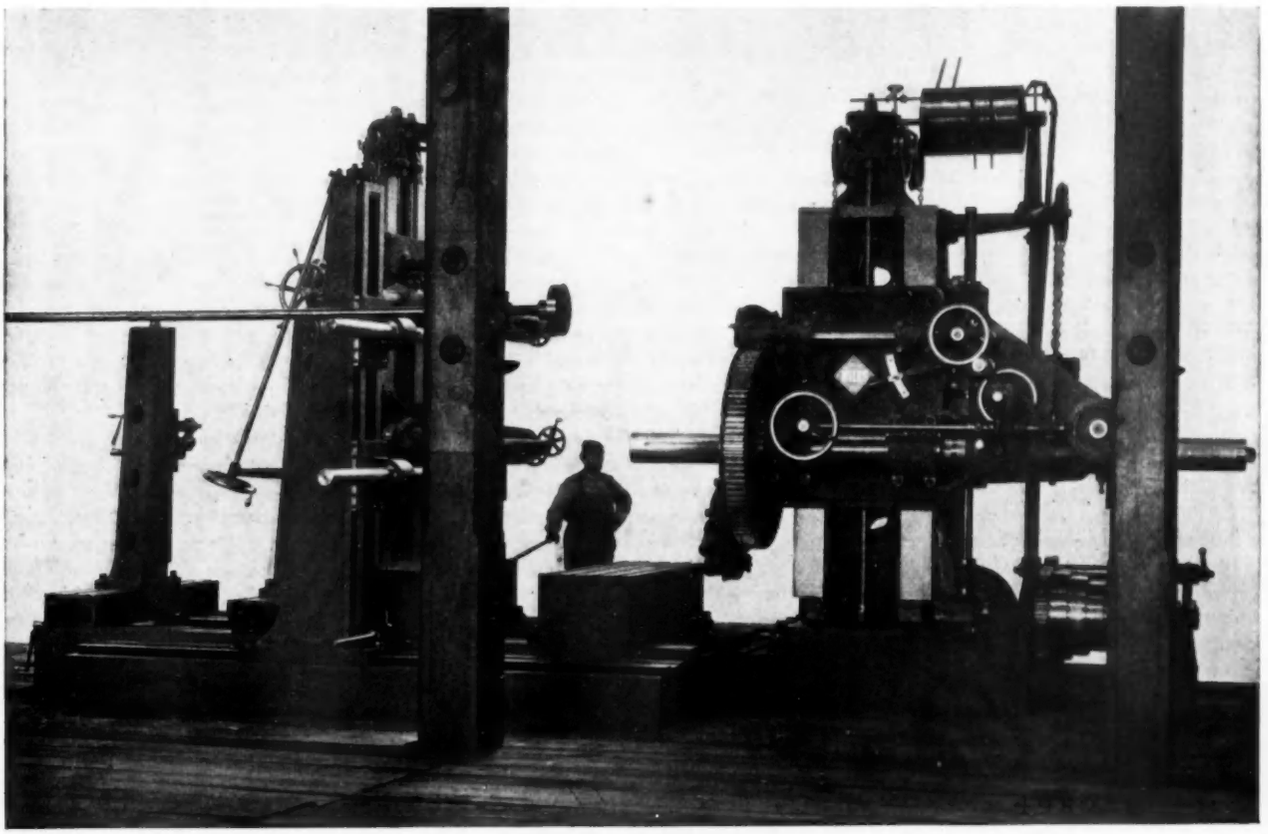
The progressive designer must learn to think. I say learn to think, for the mental process required of him is widely different from that his employer is called upon to use in the office and about his general business relations; it is one not furnished with a diploma or found in books. The designer must carry on a mental process known only to himself, and it is necessarily one that he cannot explain to others. It is built out of his "work-a-day" experience, his study, his reading and observation, it is constantly undergoing change and must continually be at work within his mind at the shop, at his home, on the street, everywhere must his mind be working out the changes that constantly call for adjustment, and if he is a progressive man, alive to his time, he soon passes beyond the mental grasp of others who are not, like himself, making these problems their entire study to the exclusion of all others.

Right here let me say to the employer or partner busy with his office, the employment of labor, adjustment of wages, purchase and sales and all the care and study this implies, that you cannot, in the nature of the case, long remain competent to discuss engineering questions with your engineer, if he is a student of his business, unless you have a mental grasp far superior to that of most men.

The designer must constantly consider the fact that others, who must be consulted, do not and cannot know the exact truth of what is in his mind to bring out in a proposed design. He must remember that no remarks of his can convey to the mind of another the whole truth about a machine which he himself has not as yet worked out by means of drawings into a design, for we must not forget that thoughts are not designs. A thought of a machine expressed in words may be an idea, but never a design until it has material form.

How few there are, who, having never been personally responsible for the creation of a machine, the delineation of details, making of patterns and the construction of it so that it will perform its work as intended, have any conception of the mental process by which the whole is accomplished. Here is one who will tell you that he is not a designer, therefore he employs you to act in that capacity, but he insists that you tell him all about the machine before you design it, in order that you may not waste time on some design he does not like, assuming to be a critic after stating what you know very well to be true, that he is not a designer, therefore unable to understand the mental picture of a design. There are hosts of men competent to criticise a completed machine, who are not fitted to talk with a designer about the detail and form of a proposed design, and when such men happen to be in authority and insist on telling the designer how to make a new machine before the design is worked out in the form of a completed machine, disaster is sure and the designer certain of failure if he tries to please. Yet how very many of the freaks sold as machine tools are born under such circumstances as this.

Again, there are so many employers and superintendents who appear to believe that there is something supernatural or mysterious about machine designing; that all the really great mechanic needs to do to produce a great improvement is to touch the paper with his magic pencil, and behold! there is the acme of all perfection. Thus it is that we see those men believing every mechanical quack who tells a boasting story of his greatness, and buying all sorts of quackery, expecting their engineer to believe in such men and to use the various quack appliances with profit to the business. They can never understand that a machine design does not flash upon the brain ready made, as the product of a great and wonderful intellect, but that it is the result of a patient, careful experiment, and that this experiment can most economically be worked out upon paper, using the T square, angles, dividers, pencil and rubber as the mind's instruments, and that good paper and instruments do actually aid the mind in its experiment. They seem to think that the design should be born in the mind full grown and mature, that all the designer need do is to sketch it free-hand on paper. Thus it is we hear so much irony about elaborate drawings and fancy instruments, the necessity for which they doubt, and insist that all you need is a rude sketch, with figures upon it, which they expect you to place there out of your brain. How they expect you to find what figures are needed before you have worked out the idea experimentally is a mystery. They seem to believe the only mission of machine drawings is to convey to the workman in the shop a correct idea of the length, height and breadth of the various parts of the machine. They can never, from the nature of their experience, understand that the drawing is also the experimental machine that the designer must create in order to find and adjust its proportions, arrange its detail, fix upon the strength of its parts and their relation to each other, and from all obtain and reason out the various measurements. Sketches have their place, but who, in the nature of things, knows best when and where they should be used



FRONT VIEW OF CYLINDER-BORING MACHINE.

—one who has given a life to such matters, or others? Yes, sketches have their place, and should be used more than they are in some shops, and some draughtsmen spend too much time upon drawings; but it is an insult to thousands of really intelligent, hard mental workers to assert, as so many employers do, that the drawing-room is an expensive luxury, or that draughtsmen are all alike, and have no conception of the value of time.

Another will insist that the designer should surrender all authority over and connection with his creation when he is through with his drawings; that several pieces of "red tape" be attached to the scheme from that on, and that the foreman should ignore the designer during the construction of the machine. In such a case as this, the designer suffers great injustice, for who is best fitted to carry a creation on to perfection if not the creator himself? Who best knows how to correct errors and supply deficiencies? for these will always be found in a new design. In fact, it is the greatest injustice to assume that the designer is through the work of designing before the machine is completed and working to his satisfaction. In justice to him and in order to obtain the best results, the drawings, patterns and construction of the machine itself, should be directly under his care, for they all serve him as means by which to perfect his creation. There is nothing quite so mean as to steal an artist's picture before he has finished it and then criticise it. The designer in very many cases must face this, and in some cases he must stand by and hear the fundamental principle of his creation set aside as worthless, when he knows full well that the critic is entirely ignorant of the principle upon which much time and study has been spent, and many times a patent obtained; and this after the critic has, when looking at the drawings and listening to the designer's explanation, expressed great admiration for it, not only to him but to others; thus showing what is so often true that he never understood what he pretended to. There is another hardship the designer is sometimes obliged to undergo. I am thankful that such employers and superintendents are very few, but there are those that will insist upon the adoption of their suggestions as to details and proportions, and when the machine is completed pronounce it a failure, and seek others than the designer to correct its errors, denying that those details and proportions were ever suggested by them.

Again there are those who go away from home once in a great while, and when they return the designer has to catch it.

"The Whale Manufacturing Company I visited do not have any drawing room at all, but a very bright mechanic, who does not style himself an M. E. (but all the same a mighty smart fellow; knows how to make dollars and cents, he does), he makes sketches on common everyday paper, with a common everyday pen, puts plain figures upon them and preserves the whole by copying in an ordinary letter press." In vain the designer explains that "we are not making whales," or that "those sketches are most likely for very simple or familiar types of tools, and that more complicated and new matters of design are necessarily worked out by drawing." The explanation, in most cases, will be unavailing. Upon another of those rare visits to other shops he will meet the mechanic of the other extreme, a bookworm M. E., and when he returns the designer has to catch it again. This time he is informed of the mystery of the "factor of safety." "All of the Bridge Manufacturing Company's tools are designed with a factor of safety, figured out from their own special and wonderful formulas. Hereafter, all our designs shall have factors of safety in them, and all the present machines must have factor of safety attachments put on." In vain does the designer explain, that the factor of safety applies to bridge construction, where weight of material beyond what is necessary for safety is objectionable, that we are not making bridges, but rather machine tools that must be rigid. Around this factor of safety question, as around many others, are gathered other fad followers beside the one just spoken of. It is easy to understand what the factor of safety means when applied to a bridge, but when applied to machine tools, I cannot see its fitness. A machine tool is worthless long before the point of breaking, or even bending, is reached (thanks to Henry Binsse for voicing this fact). When a boy I used a planer made sometime in the forties, that was not worth six cents as a planer, but as a factor of safety it was a great success. It never broke in two or bent the uprights over at an angle, you could trust it implicitly, for it would not cut deep enough to injure anything and could be left alone to itself when running, for hours at a time, with no danger of anything happening.

There must be many things beside mathematics and formulas in progressive machine designing, and first of all there should be iron, and enough to absorb or prevent all vibration. This means such an amount of iron, in such places and forms, that should a designer to-day be foolhardy enough to actually prepare the drawings and patterns for such a design, he would be told that he had "over-done it;" and, should a manufacturer dare to put such a tool on the market, he would find it difficult to get paid for the iron. Every progressive designer puts all the iron into his design that his employer will allow him to and all the buyer will pay for; he also approaches as near to real improvement in form as is safe for him to do and escape criticism from the bookworms, whose opinions, he well knows, have a strong hold on those upon whom he is dependent for employment.

Wendell Phillips once said in an address to the Phi Beta Kappa, of Harvard College, that "her workshops, not her colleges, made England for awhile the mistress of the world; and the hardest job her workman had was to make Oxford willing he should work his wonders."

How true it is many times that the hardest problem the designer has to master is the unwillingness of his employer or superintendent to allow him to progress. Many are the engineers who have succeeded only by being able to manage their superiors in authority. A great many of the inventions and the improvements that have helped to make the wealth of the manufacturers of New England, were forced upon unwilling employers by keen, careful engineers.

In very many shops, some, if not all the difficulties I have mentioned, stare the engineer in the face and, sooner or later, he drops out of the race with the reputation of being unsuccessful and others come on, only to in turn drop out, but such shops are not in the long run the successful ones; rather those in which a broader spirit prevails, where men are employed to assume and carry certain responsibilities; where men are trusted; where an opportunity is given them to prove their ability.

There are no concerns so successful as those who have a large number of loyal helpers among their employés, and there are no concerns that have loyal helpers where the employer or superintendent boasts that he does not trust anyone.

I have dwelt upon the dark side of the engineer's experience, but have not exaggerated. He is the football of the various authorities of too many shops. Were he not usually a man of resources, able to make something out of conflicting requests, suggestions and orders, much of the machinery manufactured would be useless. Why make it as hard as possible for him by standing in his way? Why not help him to give his mind and experience full play in order to bring out the best that is in him? In short, can you expect to get loyal help from intelligent specialists in any line, if you insist upon thrusting your self-confessed ignorance in their way after employing them to perform for you as experts?

I am glad the reader can say that all concerns are not managed in this way. True, there are those (I wish there were more) that are managed upon a broader plan, where intelligent employés can preserve their self-respect and enjoy the confidence of their superiors; I am also glad to note that such concerns are usually successful. Their success is due largely to the loyal helpers they have had in their employ, and this loyalty is the natural return of intelligent employés for honest and frank recognition of, and respect for them in their various positions.

Magnetic Chucks for Bicycle Work.

Our readers will recall our publication last year of a decided novelty for planer and milling machine work in the shape of a magnetic chuck by Mr. O. S. Walker, who is connected with the Norton Emery Wheel Company, of Worcester, Mass.

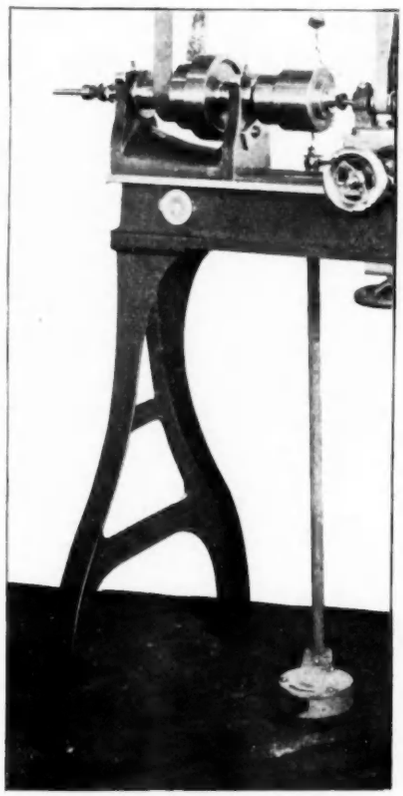


Fig. 1. CHUCK IN SPINDLE.

We show this week some recent developments of the same principle intended more especially for chucking bicycle parts such as cups, cones, etc., while being ground after hardening. The special feature aimed at in this class of work is the rapid mounting and detaching of the parts as well as absence of distortion due to the pressure of the jaws of common chucks. These operations are performed very quickly, as the lathe does not have to be stopped nor even slackened. The gripping power is controlled by the foot lever switch which is operated by the machine at full speed.

Fig. 1 shows the chuck in place upon a common speed lathe and more particularly illustrates the foot power switch which has a horizontally swinging movement.

Fig. 2 is a rear view and shows more particularly the brush holder and brushes conveying the electric current to the chuck.

Fig. 3 shows the internal arrangement of the chuck, in which B is the main skeleton of the apparatus, provided with a screw-threaded hub B^1 for mounting the same upon the lathe spindle A^1. The non-magnetic washer B^3 and the threaded flange B^4 form spool heads for retaining the coil D, the terminals of which connect to insulated rings 4 and 5, which by the detachable bushing E, which forms the external pole of the magnet and can be exchanged for other bushings of various sizes and contours to correspond with the piece to be held. The central part B is bushed with a hardened steel sleeve B^5 provided with a pin key B^6, which is inserted after the hole has been

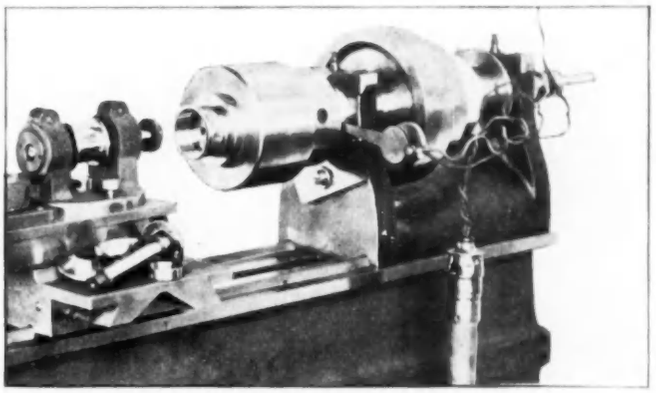


Fig. 2. REAR VIEW OF CHUCK.

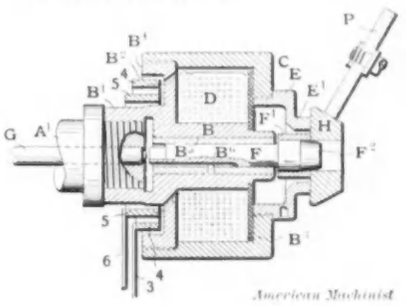
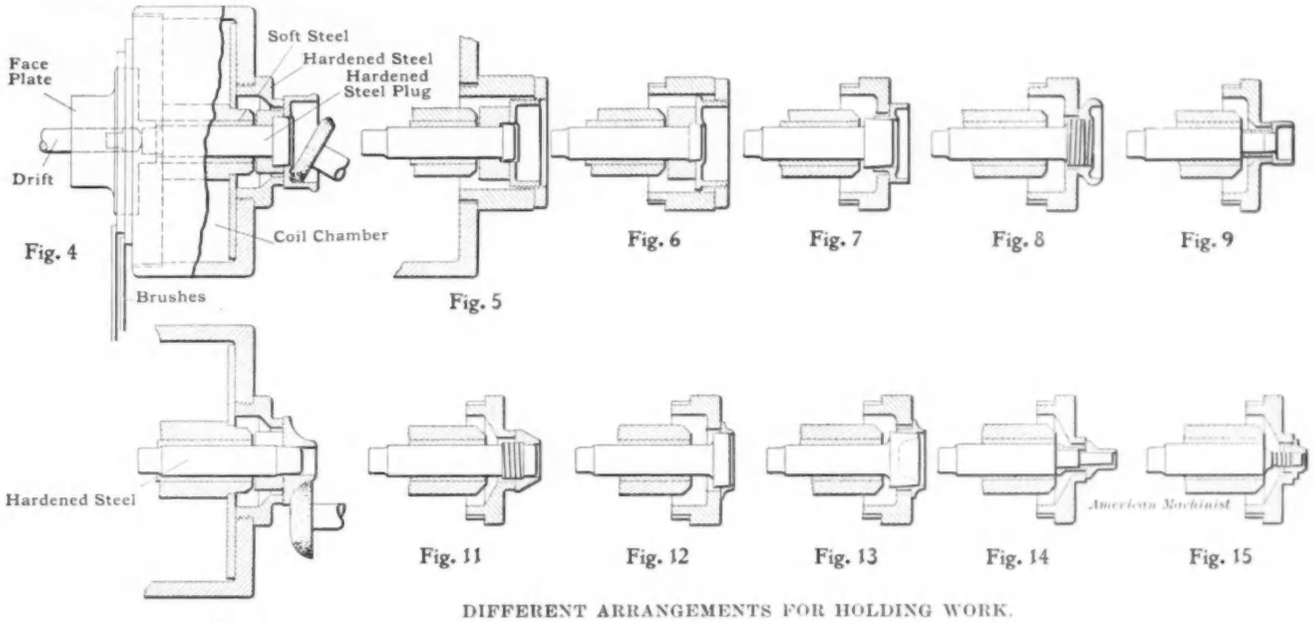


Fig. 3
SECTION OF CHUCK.



DIFFERENT ARRANGEMENTS FOR HOLDING WORK.

Fig. 10

Emery Wheel Company, of Worcester, Mass.

We show this week some recent developments of the same principle intended more especially for chucking bicycle parts such as cups, cones, etc., while being run in contact with the brushes 3 and 6. Upon the threaded flange B^4 is screwed the enclosing shell C, continuing the metallic magnetic circuit to a comparatively small opening at the front end of the chuck, screw threaded and bushed ground out dead true. Various hardened steel plugs as F are fitted to this hole and splined upon one side to fit the key B^6. The ends of these plugs are tapered slightly and fit the center holes in the pieces they are designed to center. In

some cases an adjustable soft steel sleeve F^1 is slipped over the end of the plug to assist in conveying lines of magnetic force to the back of the piece. The end F^2 of the plug F forms the other pole of the magnet and the piece of work H acts as the armature as is obvious.

Fig. 4 shows a slightly modified form of chuck and also a method of grinding cups with ball retainers. The center rod or drift is tipped with brass for an obvious reason. The work is detached from the chuck (after the current is switched off) by an impulse given this drift which passes through the lathe spindle in the usual manner.

Figs. 5 and 6 show the method of holding threaded cups which are first screwed into a knurled ring by the fingers. This ring has a tapered hole. The whole is then chucked as one piece and the threaded portion is held true. Fig. 5 is an internally threaded cup and the balance of the figures show various parts that have been fitted up for grinding.

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Letters from Practical Men.

The Mathematician vs. Constructor as a Student.

Editor American Machinist:

I have read with much interest the article by Professor Hutton in your issue of March 18th, as well as your editorial on the above subject.

I would be loth to throw cold water on any attempt to encourage the student who has a practical bent of mind. The recent agitation in regard to allowing credit for shop experience in entrance examinations has already had a salutary effect.

In most technical schools to-day, the first two years of a four-year course are devoted to the general scientific and literary studies necessary to form a groundwork for the purely technical training of the remaining two years. In the article just alluded to it is assumed that the grades in mathematics will be used to determine the future course of the student. In the schools of which I have knowledge this is only true to a degree.

If a student shows no aptitude for mathematics, he is quite likely to discover that fact himself and drift into a chemical or natural science course, to the advantage of the engineering courses. As is well stated in your editorial, analytical mechanics are the very foundation of an engineering training, and without some proficiency in mathematics the student can have no grasp upon mechanics.

As far as my observation goes, no student is rejected on account of low standing in mathematics alone, but rather on the ground of general inefficiency.

As a rule, a student who is unable to meet the very moderate requirements in mathematics is so poor in his other work as not to be worthy of retention. I think the same qualities of mind which help a man to the solution of mathematical problems will help him to the solution of engineering problems.

At the same time, the fact that mathematics is an exact science renders it possible to determine more exactly the relative standings by mathematical examinations. Ranking in the physical laboratory, the shop and the drafting room is largely a matter of opinion and judgment, and does not give an absolute standard of "to be, or not to be."

The following table shows the average standings of a class of sixteen students in mechanical engineering, and will serve as an illustration:

No.	Sophomore Mathematics.	Physics and Physical Lab.	Shop Work and Drawing.	Mechanism and Machine Design.
1	90	90	76	86
2	88	87	81	85
3	85	81	89	75
4	83	84	86	79
5	81	78	83	80
Average	85	80	83	81
6	80	84	92	86
7	80	92	76	75
8	74	90	77	77
9	74	78	83	73
10	73	79	78	70
11	72	83	87	73
Average	75	84	82	76
12	69	82	74	80
13	67	82	78	70
14	66	77	70	70
15	65	77	77	50
16	64	87	77	74
Average	65	81	75	69

The men are arranged in the order of their excellence in analytic geometry and calculus. It may be seen that the averages in the technical studies of the junior-year mechanism and machine design correspond closely to those in the mathematics of the sophomore year, and bear but little relation to the grades in physics and in physical laboratory.

On the other hand, the men who fall into the third division in mathematics show a low average in the shop and drafting room as well.

That there are some exceptions to these rules is evident, but I have never known of a case where a man who failed in mathematics showed sufficient ability in shop work and drawing to warrant any special effort being made to retain him.

After all, the important consideration is to teach students the things they cannot learn outside, such as theoretical physics and mechanics, and in order that this may be done thoroughly, the students must understand mathematics.

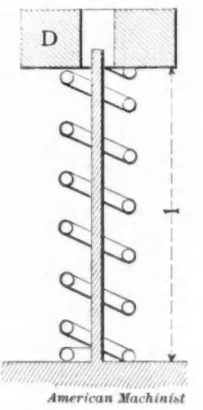
CHARLES H. BENJAMIN,
Case School of Applied Science.

Modulus of Elasticity for Steel Helical Springs.

Editor American Machinist:

In the "American Machinist" of August 18, 1892, Mr. J. Begtrup calculates a very important table concerning spiral springs. But he supposes in this table that the modulus of elasticity of three kinds of steel is of 10,000,000, 12,000,000 and 14,000,000 pounds. It is of great consequence for me to acquire two springs in which (see the table) $d = \frac{3}{8}''$; $D = 4.''\frac{1}{2}$; $W =$ 301 pounds; $F = 0.''2761$. They give me with 114 coils all that I want; that is to say (see the design) : $l = 137.''35$, for $P =$ 0 pounds; $l = 80''$, for $P = 182$ pounds; and $l = 42.''75$, for $P = W = 301$ pounds (safe load).

Now, before I order those springs, I fear they may not work as well as the calculation shows, because the modulus of elasticity of steel is 29,000,000 pounds in reality (see Molesworth's "Pocket-Book of Engineering Formulae") and not 10,000,000, as Mr. J. Begtrup's table shows in my case.



Kindly put me in connection with Mr. Begtrup, and if this is not possible, be so kind to obtain in any other way an answer to this urgent question, so that I could be sure to get my springs working nicely in the above-mentioned conditions without any permanent remaining deflection.

PRINCE ANDREW GAGARINY.
St. Petersburg, Russia.

Editor American Machinist:

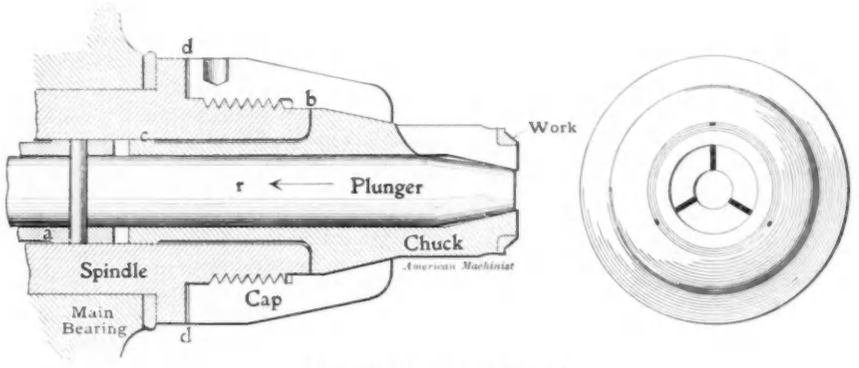
When I calculated my table, I had reason to believe that a modulus of 12,000,000 would generally give satisfactory results, for I found it to agree very well with the deflection of helical springs of medium size steel, which I had tested myself and also with the spring-maker's tests. Later I had considerable experience with springs made by French in Pittsburg, of round steel, ¼-inch to ½-inch thick, and I found the actual deflection came very near the figures in my table. But I have also had experience with closely wound springs, which had a considerable initial tension, that is considerable weight must be applied to the spring before it opens at all. For such springs my table would not be

of much use without some knowledge of the initial tension. I have not had much experience with these springs, and do not know whether a modulus of 12,000,000 would give correct results. I have used the two modules, 10,000,000 and 14,000,000 in my table, to make it more useful if they should be found to give better results, also hoping that experimenters might, by using my table, establish a more correct or generally useful modulus.

Your correspondent mentions a modulus of 29,000,000, which he found in Molesworth's Pocket Book. I think this is a generally accepted modulus for bending deflection, but the modulus for torsional deflection is considerably less. Dr. Reuleaux, in "Der Konstrukteur," gives it as ⅔ of the modulus of bending, and according to the same authority, a torsional modulus of 8,000 kilograms per square millimeter, may be used for spring steel, which is 11,378,240 pounds per square inch. It is not hard to understand why a smaller modulus must be used for torsion, when we consider that the molecules, instead of pulling straight apart are moved sidewise, a displacement of which we may obtain a clearer conception by comparing it with a sliding motion of the individual molecules.

J. BEGTRUP.

Hartford, Conn.



A CHUCK FOR THIN WORK.

Special Chucks.

Editor American Machinist:

One occasionally comes across a piece of thin work on which all of the operations cannot be performed at one time, and which will not stand the cost of placing on a mandrel and finishing in an engine lathe. The expanding chuck, of which this sketch is a section through the center, answers to perfection, and is used on a screw machine. The principle can be applied to any screw machine that has a sleeve similar to *a* to close the chucks when working on solid stock as rods, etc. (the Parkhurst feed).

The chuck has a bearing on the spindle at *b* and *c*, and is held rigid by the cap which comes very close to, but does not bear against the spindle at *d*.

Moving plunger *r* in the direction of the arrow allows that part of the chuck that is milled in three parts to close together a small amount, when the work, no matter how thin and fragile, can be removed. This chuck is also good on heavy work, as it will hold very tight and not injure the smoothest hole in the least.

ED. SNYDER.

Chicago, Ill.

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Reciprocating Parts of High-Speed Engines.

Editor American Machinist:

The letter of your correspondent, Walter Rachals, who I observe writes in a representative capacity, as voicing the views of engineers generally, seems to present a sound argument. The only objections that I note to it are its antiquity, and that it misses the point.

The writer is reviewing ancient history; he is not up to date; and his thunderbolt was not aimed at the mark. He charges right valiantly against his man of straw, and prostrates him in the dust; proving conclusively by the aid of diagrams which have a familiar look, something that everybody knew before.

He then clinches his argument by the authority of Radinger, quoting what he informs us was written by Radinger twenty-seven years ago, evidently under the impression that the value of authority, like that of whiskey, increases with age. I certainly ought not to object to what Radinger then wrote on this subject, as a couple of years before I had written something very like it myself, and "engineers generally" might have told him where Radinger got the idea.

But a good many things have happened in the last twenty-seven years. Engineering has sailed far on the sea of progress, and its wake is filled with debris. Among other rubbish, the idea that the pressure on the crank ought to be made uniform through the stroke has disappeared below the horizon a good while ago.

This idea was a step in the right direction, but it was only the first step, and those who have aimed to keep at the front of the procession have had to take a few more steps. What we are talking about now is, how the steam pressure can be applied to the crank in the best manner In the language of our late President, we are confronted by a condition. We are going soon to use steam of 300 pounds pressure, in engines making 300 revolutions per minute, and the practical question is; how shall absolute freedom from both knock and vibration be secured? The inertia of the reciprocating parts exerts a pressure on the crank, which, however great its amount, always commences insensibly, and is gradually accumulated. The high speed engineering of to-day applies the pressure of the steam to the crank in precisely the same way.

I cannot close this letter without expressing my appreciation of the thoughtful communication of Professor Stanwood, in your issue of March 4th. The point that inertia of the reciprocating parts, in excess of the steam pressure on the centers, tends to produce a knock in the guides is well taken, and this tendency needs to be guarded against. But it will be observed that the transition of the angularity of the connecting-rod, from one side of the line of centers to the other, is also made in an insensible manner, so that the side thrust ceases in one direction and commences in the opposite direction in a corresponding fashion. For this reason, it is found in practice, that all the freedom of the cross-head between the guides that there is any occasion for may be had without risk of knock, especially if the guides are properly lubricated. This assumes, of course, that the engine runs in perfect alignment. Here, as everywhere else, high speed is a sure revealer of constructive defects.

CHARLES T. PORTER.

Montclair, N. J.

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Safety-Valve Formulas.

Editor American Machinist:

I have read with much interest Mr. Hemenway's article on safety valves and their required area. As I believe it will interest your readers, I will translate into formulæ the rule given by the writer:

If with him we assume the quantity of coal consumed per square foot of grate surface to be 17 pounds, when only one valve is used, we have for its diameter,

$$d_1 = 1.035\sqrt{S},$$

if two valves are used, we have for their respective diameters,

$$d_2 = 0.732\sqrt{S},$$

but if the quantity of coal consumed is different from that assumed, we have,

$$d_1 = 0.251\sqrt{Sq}, \text{ and}$$

$$d_2 = 0.177\sqrt{Sq}, \text{ where}$$

S = grate surface in square feet,

q = quantity of coal consumed per square foot of grate

The rule used in this country for steamboat as well as for stationary boilers is

that prescribed by the British Imperial Board of Trade, which is easier applied than that given by M. Hemenway, because the quantities are more easily known.

From the rule of the above-named Board I have deduced the following formulæ:

Where p = absolute pressure—that is, boiler pressure plus 15 pounds—

$$d_1 = 6.91\sqrt{\frac{S}{p}},$$

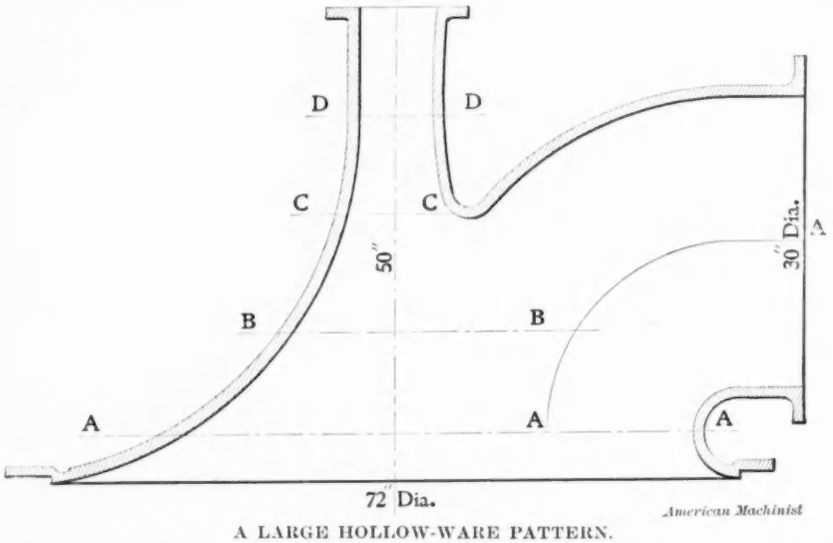
and for twin valves, which are almost universally used, the respective diameters are,

$$d_2 = 4.89\sqrt{\frac{S}{p}}.$$

J. G. GOULET.

Sorel, Canada.

[While the factor P employed by our correspondent properly belongs to a safety-valve formula, as helping to determine the volume of steam to be discharged, it is, of course, valueless, as, indeed, are all the other factors, without the q used by Mr. Hemenway, as here formulated by Mr. Goulet, for all depends, first of all, upon the quantity of coal consumed. If our correspondent's rule is, as claimed, easier, the ease would seem to be obtained at the expense of reliability.—Ed.]



A LARGE HOLLOW-WARE PATTERN.

A Large Hollow-Ware Pattern.

Editor American Machinist:

I have for many years looked on dry sand cores as a necessary evil in the molder's art, and nothing more; sometimes necessary for one reason and sometimes for another, but always to be avoided where practicable to do so. A few hours spent in study over a drawing will often show you a practical way to avoid using them, and will save many times over the time so spent when you come to make the pattern. I recently had a case of this kind, although I suppose some hollow-ware molder will say when he reads this, as one said to me after I had finished the pattern, "Why, that is just the way we make a teakettle." But I don't care if it is; it was a good way to make this casting as well, so I am going to tell you about it. The casting was the head and part of suction pipe for a 42-inch centrifugal pump, and weighed in the neighborhood of one ton. Herewith is a sketch that I think will clearly show what it was like.

The body of the pattern was built up in segments, turned inside and out and parted on lines A B C and D, each ring being grooved into the next to keep them fair with one another. After these were all turned up, I built the elbow up in segments about three-quarters thick, of course laying it out beforehand to get the width and the sawing correct, so that when I came to work it off I would have the lines to work to, the same as I would in a propeller wheel. I built this elbow in place against the body of the pattern, fitting each segment to it as it was put on. Instead of nails on this pattern I used ¼-inch wooden pegs, and by boring the holes a little slanting with each other I was surprised to see how they would draw, and would squeeze the glue out of the joints nearly as well as hand screws. On the outer end of the elbow I had a template to build to, but for the inner end I depended entirely on the lines that I put on each segment as I laid it out. After this was all done and smoothed up inside and out, I fitted pieces of pine around it to form the large fillet where it joins the head, and worked this out afterward, gluing muslin to the inside of the fillet to keep the edges from breaking, as there were to be six of these castings made from the one pattern. Then I fastened the flanges on and cut the hole through the body-piece. This practically finished the pattern.

The arbor or lifter plate was simply a round plate fitting the pattern at A, and having three good taper pins on the bottom to guide it to place after lifting out. To this was bolted a piece the shape of the elbow up to the center line, this again having bars cast on it to carry the sand in the elbow. The flask consisted of a plain drag about eight inches deep, a chuck that started at the center line of the elbow, following that line down to A, and then square across, and a cope to match this.

The molding was started by bedding down the bottom ring of the head and ramming up the inside. Next the cheek was put on and the bottom half of the elbow. After ramming this up outside and making parting to line A A A, the plate was put in and the other rings of the head as needed, and finally the top half of the elbow, finishing the core in this from the outer end. Then the cope was rammed up, taking the top flange out and covering with a core. The neck from D up was a dry sand core inside. After lifting the cope, and the pattern with it, to the line A, the core was lifted on the plate and the bottom half of the elbow was drawn out. The cheek was then lifted and the bottom piece to line A drawn.

Six of these were made, and they were all good, nice castings of even thickness, and no ragged places either inside or out, as there would have been with dry sand cores. I know that this pattern did not cost as much by considerable as it would made in any other way that I know of, and the pattern is just as good to-day as it was when made, notwithstanding that it was about half rammed up one day when a fire occurred in the roof directly over it, and the water made mud out of the mold, and the pattern soaked there for about a month until the adjusters got the damage settled. I think the wooden pegs saved it here, as they will save a good many patterns if used with discretion.

CHARLES H. ALLMOND.

Seattle, Wash.

[As to the miraculous endurance of this pattern under inimical conditions, as narrated in the last paragraph, our readers will notice that it occurred on the Pacific Coast, where atmospheric conditions are different from those found elsewhere. —Ed.]

▲ ▲ ▲

The Divided Chip of the Twist Drill.

Editor American Machinist:

The drill shown in the issue of March 25th is quite an interesting contribution to the twist drill discussion, the end of which seems to be not yet. I may as well say plainly and at once that, in my opinion, the twist drill manufacturers were wise in not undertaking to make that drill. Saying nothing now of the fact that the drill would cost more to manufacture than the plain twist drill, there are other features about it that are not altogether desirable when fully understood—that is, as I understand them. Although the half-tones are very good, as half-tones go, they still fail to show quite clearly and completely the entire shape of both the cutting edges. I understand, however, that each lip is

divided into four nearly equal divisions, comprising two projecting cutting portions and two depressions that do not cut, and that the depressions upon one lip are at the same radial distance as the projections on the other lip. The action of the drill in cutting, then, is that, instead of cutting two chips each the whole width of the cutting lip, it cuts four chips, two with each lip, and each chip only one quarter the width of one lip.

The proposition to divide or break up the chip, as this drill is designed to do, sounds, I admit, rather enticing at first, but the actual reduction of the effective cutting edge by one half is a rather serious affair. Of course, the projecting ribs of each lip cut and the depressions do not. The outside corner of only one lip, instead of both lips, will cut the finished interior surface of the hole. The drill must, of course, wear away twice as fast and require twice the amount of grinding for the same amount of work. At each grinding, in order to resharpen the worn projecting ribs, we must also grind the depressions, comprising approximately one-half the lip line, and entirely unworn.

It can scarcely be argued that the conditions alluded to are anything to be proud of in any drill. This drill might have the advantage of being able to hold a finer feed than the standard drill, if there could ever be any necessity for that, as, with one half the actual feed, the cutting ribs of each lip would have the same thickness of cut that the full feed would give to the entire lips, if both were cutting along the whole line. The drill would, in fact, insist upon having all the while a finer feed than the regular drill, and could not, at its best, work with as coarse a feed as the regular drill.

I have written thus far under the assumption that the drill was actually designed for the purpose of producing several separate narrow chips, instead of chips the full width of the lip and of uniform thickness, the idea being that the drill would cut easier on account of the division of the chips. I have also assumed that the drill would actually do just what it was designed to do in the way of producing the separate chips. It is very probable, as a matter of fact, that if the drill was properly crowded, so as to do all the work it was capable of, the entire lip would cut. I feel quite certain that it would, and that the original theory would be knocked out of sight. The chip thus produced would be a chip the full width of the lip, the same as the chip of the common twist drill, and on the inside of each chip, as it rolled away, there would be two stiffening ribs or projections, thicker than the normal thickness of the chip, due to the feed employed. While the theory proposed one thing, practice would develop another, and I can hardly see that either theory or practice in this case can do much to help the poor drill. It does not appear that the drill would be in any way a desirable one for use, and the discussion of it may seem to many a waste of time, except that it may help us to a better understanding of drills in general.

The drill shown in the issue of December 17th, which seems to have been chiefly instrumental in starting the recent talks about the twist drill, also embodied the idea of producing a divided chip, but in that drill both lips were alike, and each lip cut with the entire face of it, and there was no sacrifice of cutting edge in theory or in practice. There was in fact an increase of cutting edge over that of the common drill, but it was secured by the adoption of another feature which did more harm than good. The cutting faces of the drill, it will be remembered, were made with two or more circular grooves, which combined comprised the entire lip on each side, and the chips that were cut were curved in section, instead of straight, and would necessarily, when the drill was cutting, require more force to roll them away on that account.

It is not every mechanic, even if handling twist drills every day, who realizes the fact that the cutting edges of the regular twist drill, when ground to the usual angle, are practically straight lines, and probably fewer still realize the importance of keeping the edges straight if free and easy cutting is desired. Whatever improvement may be in store for the twist drill, or whatever drill may supersede it, the cutting edge at its best will be a straight line, rather than one consisting of a series of regular or irregular curves or zig-zags.

TECUMSEH SWIFT.

▲ ▲ ▲

Special Tool Steel.

Editor American Machinist:

Of course, we are accustomed to seeing a variety of things reinvented periodically, but the "special tool steel" of the Waverly Works, Sheffield, England, noted in your issue of the 8th inst., is a little the oldest thing that has reappeared lately.

This section is an exact reproduction of one of the forms shown in the patent to R. French, granted November 11, 1834,

before the United States Patent Office began numbering its issues. Fig. 2 of this patent is like the accompanying sketch, and the groove on each side is described as "an obtuse angle from the longitudinal center to the edges," the figure showing equally clearly the strengthening at the apices of the joined triangle. The specification describes the subsequent twisting and its use for augers.

NOVICE.

[All of which shows the length of time which sometimes occurs between the invention and introduction of a useful device.—Ed.]

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Cast Iron for Bearings.

Editor American Machinist:

The discussion in your paper as to the value of cast-iron bearings interests me much. I think a great many of those who are prejudiced against cast iron have good reasons for it.

If soft, porous or crumbly cast iron is used it will wear much faster than good babbitt, or even poor babbitt or brass. I have seen cast iron so crumbly that you could almost pick it to pieces with your finger nails. There being so much difference in the quality, then, of "cast iron," it seems to me that it would be well for those advocating its use to lay stress on the fact that it must be good, strong, close-grained iron, free from sand holes.

I have been an enthusiastic advocate of cast iron as a journal for some years, and have always had the best of success with it on fast-running arbors.

In the case of a small loose pulley, which recently came under my care, and which had always been bushed with brass about once a week, a good, clean, cast-iron bushing of strong, close-grained iron stopped all trouble. It has now been running several months, with but little signs of wear. This pulley is 3 inches diameter and 3 inches long, ⅞ hole, and runs 7,000 revolutions per minute.

GLASSES.

▲ ▲ ▲

A Hint on Cutting Large Gears Accurately.

Editor American Machinist:

Some time ago there was some discussion in the "American Machinist" as to whether or not it was hurtful to stop a tool when part way through a cylinder. How the matter was settled is not known to me, but I do know that a gear is liable to be inaccurate if it is allowed to stand after it is partly completed. It has been the practice of the writer on nearly all spur gears, and especially arm gears, not to cut the spaces consecutively; but instead, to cut every fourth or fifth space, and in that way miminize the expansion of the rim, due to the heat in cutting. I would say that the old machine is not automatic, but is indexed by hand, and it is almost as easy to index four or five divisions as one.

ED. SNYDER.

Chicago, Ill.

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We certainly should send some mechanical missionaries to England. "The Hardware Trade Journal," London, says: "Pulleys made partly of iron with wooden rims are not unknown in England, but we were hardly prepared to see pulleys made entirely of wood recommended for use in the present age." This locates the journal mentioned nearly a generation behind American practice.

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Responsibility and Control.

Among our readers there will be many who will consider the picture by Mr Hotchkiss in another column of this issue overdrawn. A good many engineers and machinery designers happily escape such an experience as has evidently been his lot in part, but nevertheless there can be no doubt that he puts his finger on the spot that is the very weakest point in many machinery building establishments.

The great fundamental truth that, in order to call out men's best efforts, they must be responsible for something and then must be given control within the lines of their responsibility, seems difficult for many to understand and appreciate. It is safe to say that no one who fails to grasp and put in practice this principle of individual responsibility and control commensurate with it can by any possibility ever become the successful manager of any large enterprise.

Of course everybody knows this in a general way; it is a fundamental principle of military science and is taught and retaught by all human experience; which makes it all the more surprising that there should be machine shop proprietors who seem to know nothing of it, and who are continually giving detailed instructions on subjects they know nothing whatever about to men who know all about them, and are employed for no other reason than because they do know all about them; thus effectually preventing the accomplishment of the work for which a salary is paid, and which is vitally necessary to the success of the establishment.

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Profitable Communicativeness.

Competing industrial establishments, if their contemporaneous existence is prolonged, must fight on nearly equal terms. No pronounced and permanent superiority can reside with either. There must be, with both if with either, a constant effort and a consequent tendency to advance. One may gain an advantage by aggression, or, as they say in warfare, offensive devices, but if so the other must quickly meet and parry them defensively. The plane upon which the struggle is carried on matters little, and least of all to those most seriously engaged. The employer can pay high wages as well as low wages as long as his competitors must do the same. He can afford to be slack and careless if others are equally so. The new process or the improved machine may not interest one until he finds them advantageously employed elsewhere, but then he must be alert to adopt them. It may be possible to be satisfied to do as well as our neighbor, but there is no safety in anything short of that. To have a fighting chance conditions must be nearly equal.

There are those who, in the above view of the case, are unable to understand how American shops can be run in such an open and public way as they are. It is well known to all the world that American manufacturers have few trade secrets, and that they are very free to let each other, or to let anyone who wants to, see what they are doing and how they are doing it. It is carved in stone over the doorway of the Straight Line Engine Company, "Visitors always welcome." This marks an admirable personal characteristic of Professor Sweet, but it is also largely characteristic of American shop proprietors everywhere. The attitude is instinctive and spontaneous and does not come of any conscious planning, so that there may be in it little to boast of.

We hope to see the practice continue without the slightest diminution. We cannot in fact afford to give it up. There may be some apparent advantage in having shop secrets and in keeping them to ourselves, but it works both ways. If it works for the good of any individual it also works against him. No one man and no one firm has a monopoly of enterprise or inventive faculty, or of the advanced means and methods developed by them. If we choose to work on the lower plane of going it alone, and of never letting our neighbor know our best way of doing a certain thing, he can play the same game and also keep his ways and means all to himself. The practical result of the general adoption of the narrow and selfish practice would be that neither would possess any advantage over the other, any more than under our more liberal policy, but that each would be less expert and less productive and distinctively lower when it came to world-wide comparisons and to competition in the open market of the world. We have been distinctly the gainers in taking the liberal course, and stand firmer and on higher ground by reason of it. Mutual liberality has been reciprocally helpful. We have all around each lifted the other. It is to be hoped that we will never fall into the old world habits of guarding trade secrets and maintaining trade jealousies. It does not look well and it does not pay.

▲ ▲ ▲

Pratt & Letchworth, Buffalo, N. Y., have established an employés' club, or rather a club room. It is located in a building near the office, has a large hall supplied with game tables, a piano, a library of 1,000 volumes with a large list of periodicals, and a billiard room with billiard and pool tables. It is open on week-day evenings and on Sundays. The firm pays all the expenses of maintenance, and the rooms are freely used by the employés, who find in it a great source of comfort and pleasure.

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Mr. F. G. Kretschmer, New York representative of the Brown & Sharpe Manufacturing Company, sailed for Europe on Tuesday, the 27th inst.

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Mr. E. J. Condon, for the past fifteen years foreman of the Birmingham Iron Foundry, has severed his connection with that company.

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Questions and Answers.

Name and address of writer must accompany every question. Questions must pertain to our specialties and be of general interest. We cannot undertake to answer questions by mail.

(55) H. M. A., Pittsburg, Pa., asks how to obtain the pounds pressure due to the blow of a steam hammer. A.—Under ordinary circumstances this can only be expressed in foot-pounds. The actual pounds pressure experienced depends upon the abruptness with which the motion of the hammer head is arrested. You will find the principles involved explained at length in answer No. 6, which appeared in our issue of January 14th, this year.

(56) H. S., Eureka., asks if there is any economy in compound non-condensing engines over simple engines having the piston area equal to that of the low pressure of the compound. A.—Where the

steam pressure is high and the number of expansions great, compound non-condensing engines are more economical than simple engines using the same ratio of expansion. We are not aware, however, that the dividing line can be accurately located.

(57) P. L., Fitchburg, Mass., asks: What is the formula for calculating the quantity of air which at any constant pressure will escape through an opening of any known area? For instance, how was the answer calculated to Question 41, April 8th, where air at 60 pounds gage pressure was discharged through a 1-16-inch round hole at the rate of 3½ to 4 cubic feet of free air per minute? A.—The answer to that question was not calculated by formula, but was taken from records of actual experiments. The following formula gives the theoretical discharge:

$$V = A \times 37.8 \sqrt{P \times P'}$$

V being the volume of free air discharged in cubic feet per minute, A the area of the orifice, P the absolute pressure, and P' the gage pressure. The actual discharge will be less than indicated by this formula, and may not be more than from 50 to 70 per cent. of it. Applying the formula to the case above we have:

$$V = .003 \times 37.8 \sqrt{75 \times 60} = 7.59$$

and 50 per cent. of this is 3.8.

(58) M. P., New Whatcom, Wash., writes: 1. Theoretically, if compressed air is re-expanded in a cylinder it loses the same amount of heat that was produced by its compression; for example: if free air with an initial temperature of 60° is compressed to 50 pounds gage, its temperature is 339°, the increment being 279°; if it is now cooled to 60°, the pressure remaining at 50 pounds, and if it is then admitted to a cylinder and re-expanded to atmospheric pressure, the temperature will fall 279°, and the volume will be as the absolute temperature; is this correct? A.—If the air is expanded from 50 pounds gage to atmospheric pressure, the ratio of pressures will be $\frac{15}{50+15} = .23 +$ and for this ratio of pressures the ratio of absolute temperatures will be .65. The final temperature, then, will be $(60 + 461) \times .65 = 338 - 461 = -123$, and the decrease in temperature will be $521 - 338 = 183°$. 2. If, however, before the air is used it is reheated to 400°, and is then used as above, will the temperature then fall 279°, the original increment during compression, or will it fall more? A.—In this case the ratio of pressures will be, as before, .23 +, and the ratio of absolute temperature will also be the same, .65. The final temperature, then, will be $(400 + 46) \times .65 = 559 - 461 = 98°$, and the decrease in temperature will be $861 - 559 = 302°$.

(59) J. J. S., Birmingham, Eng., asks: A piece of solid cold iron will float in molten iron which formerly had the same specific gravity. Is this conclusive that the molten metal has the greatest specific gravity? If so, have any experiments been made to determine the increase? A.—The fact of any solid floating in a fluid is proof that the solid has the lesser specific gravity. Cold iron will not, however, float on molten iron. The action of a piece of cold iron placed in a ladle of molten iron of the same composition depends upon what the composition is, the action being more pronounced as the iron contains more silicon. If the silicon percentage is high enough, the iron at first sinks, then rises, then sinks a very little, then rises again for an instant, and immediately thereafter melts and loses its identity. This is the typical behavior, but it requires high silicon iron to be pronounced enough for ordinary observation. These changes are due to the combined effects of expansion by heat and the chemical changes going on in the iron. At the point where the carbon goes into solution, and while the material is still solid, the volume increases rapidly, causing the first flotation; a further increase of heat causes shrinkage, followed immediately by a slight increase, after which a further slight rise in temperature causes the metal to melt. You will find some beautiful illustrations of this action shown by autographic records in the transactions of the Iron and Steel Institute of Great Britain. In the transactions of the American Society of Mechanical Engineers for 1895, you may find further information in connection with Keep's cooling curves for cast iron, which show the behavior of cast iron as regards volume under the influence of heat.

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Technical Books.

FUEL AND REFRACTORY MATERIALS. By A. Humboldt Sexton. 352 5 x 7-inch pages; with 104 illustrations. D. Van Nostrand Company. Price, $2.

This book is intended to fill the gap between extremely scientific treatises on the one hand and the brief outlines which are often included as chapters in books upon other subjects. The book is quite comprehensive, treating of the various forms of solid, liquid and gaseous fuels, including their properties, preparation, manufacture and uses. Chapters upon pyrometry, calorimetry and the testing of fuels are included. The section upon refractory materials covers but a small part of the book, and treats especially of fire bricks and crucibles for metallurgical purposes; in fact, the entire book has a direct bearing toward the metallurgical uses of fuel, and devotes a great deal of attention to coke-making and gas producers. A large amount of information is contained within small space, and the book will no doubt serve as a very useful manual for a great number of readers. A certain amount of elementary chemistry is used, but the chemical treatment is subsidiary, and those not acquainted with that subject may read it with profit. Of mathematics there is none beyond a few very simple algebraic formulas.

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A Lathe Job.

Editor American Machinist:

I should like to get your opinion as to the proper method to be employed in cutting a left-hand inside thread to a shoulder, say in a nut, as shown in sketch, Fig. 1.

My method would be to hold the piece in a chuck, jam the chuck against the shoulder on the spindle sufficiently to prevent its turning off under a reasonable cut, and then, using a left-hand inside tool, run the lathe backwards and start the tool in the cut on the outside, then run in and terminate the cut at the shoulder. Is this method right or wrong?

WILLARD B. VOSE.

[The work could be done in the way proposed, but we do not quite like it. We would not like to depend upon the jamming of the chuck against the shoulder, and we do not like the practice of jamming the chuck against the shoulder a bit harder than is necessary. It would often be a convenience if we had some good way of holding a chuck or face-plate against heavy cuts with the lathe running backward, and still be able to unscrew easily when required. Some boring jobs that just carry the weight of a heavy overhanging piece in the chuck, can be done more comfortably with a bearing-down cut than with a lifting cut, other things being equal; but as we have not

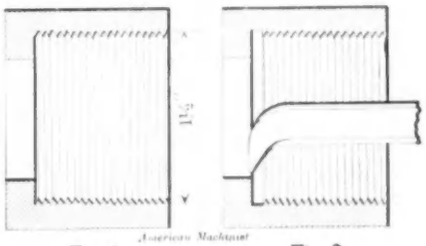

Fig. 1 Fig. 2

the means of holding the chuck or face-plate except by "jamming," we cannot make a practice of depending upon that.

But this has nothing to do with the case proposed by our correspondent. We would, in the first place, always insist, in a job like the sketch, upon having a groove in the inner corner turned out to the larger diameter of the thread, and we would start the tool in that and cut outward. The tool might be something like the sketch in Fig. 2, with the end about flat, and only enough of the V on that side for the required thread, or a little more. The tool might be moved back enough in this case to run a little way into the back hole when backing, and then the lathe could be run ahead to take up the slack, and when the end of the tool would clear the shoulder the tool could then be run out and set for the cut, using the stop gage and setting the tool out a little more for each successive cut. After the first cut, a chalk mark on the chuck should show the exact position for it for the tool to clear the shoulder inside. A slight mark on the shank of the tool would show within one thread how far to back in, and then turning the chuck ahead to the position indicated by the chalk mark would do the rest. With a little practice in this line, the apparent difficulties disappear.—Ed.]

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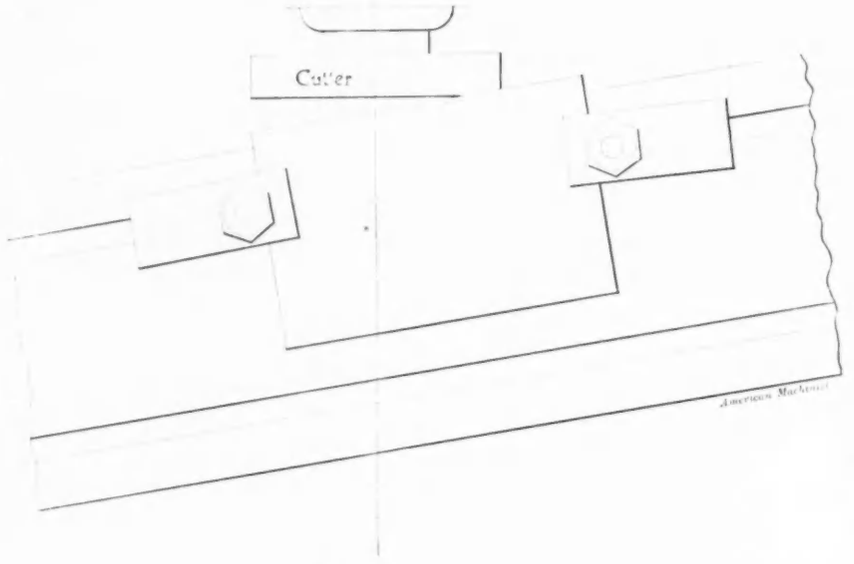
Elliptical Milling.

A correspondent sends us a little sketch, as herewith, telling us that he lately had occasion to machine some pieces with one face concave to fit a cylindrical surface

with a radius of 8 feet *exactly*, and that he did it on a universal milling machine by setting the table at an oblique angle, as shown, and feeding the work past the cutting edge of a milling cutter of large diameter. He says that any such circular work of large radius may be milled in this way, and that it does not matter what may be the diameter of the milling cutter, so that it is larger than the width to be milled. He furthermore inquires whether the method is new or old, as he never saw or heard of it before.

Our friend is undoubtedly mistaken. A milling cutter under the conditions described would produce an elliptical surface, and could not possibly produce anything else. As the radius he mentions is comparatively a large one, he probably could not very well discover that the profile of his work was not strictly circular, and it probably was perfectly satisfactory for his purpose. If the milled surface was, say, six inches wide (and from the sketch we may judge that it was not more than that), the depth in the center, with the eight-foot radius, would be less than five one-hundredths of an inch, and the lack of coincidence between the elliptical and the circular lines, supposing them to coincide at the edge of the piece and also in the center, would be very minute.



ELLIPTICAL MILLING.

It is not necessary to go into any mathematics, or even to make a diagram, to show that the profile produced by the cutter would under the circumstances necessarily be elliptical. With teeth both on the edge and on the face of the cutter, and assuming, for our present purpose, that the extreme corner of the cutter did all the work, we know that if the piece were fed across the face of the cutter it would be milled perfectly flat, while if it were swung around square and fed past the cutter in a direction parallel with the cutter spindle, the milling would be circular, and the radius of the circular cut would be the same as the radius of the cutter.

Now starting from the flat milling, and changing the angle a little at a time until we got around ninety degrees to the truly circular milling again, there would be no point where there would be a sudden jump from the flat to the circular. The flat work would cease at once with the first change of angle, but the circular would not begin until we got around all of the ninety degrees. The first departure from the flat milling would give the profile of a very thin ellipse, and as the angle increased, the thickness of the ellipse would increase, the long diameter of the complete ellipse remaining the same as the diameter of the cutter all the while, and when the full ninety degrees was reached both diameters of the ellipse would be equal, and that would be a circle.

Our correspondent's query serves to call attention to the ease with which internally elliptical profiles may be cut on the universal milling machine. It is not at present very obvious what practical use may be made of it until we have some equally facile method of producing externally elliptical surfaces. Oval shafts in oval holes would ask little help from keys. Oval feet for brackets on corresponding frame surfaces might sometimes be useful, but they are not likely to be adopted.

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An air compressor is evidently needed at the Aquarium in this city. The institution recently acquired two enormous lobsters, which would have been a valuable attraction, but both died after a few days. Lobsters are in the habit of spending their time at great depths in the sea, and consequently under great pressure. The pressure could, of course, be supplied by compressed air, and tanks might be made of the required strength. The flat glass plates would, of course, be impossible, but any number of small round disks of thick glass might be used. Many deep-sea organisms might be accommodated in this way.

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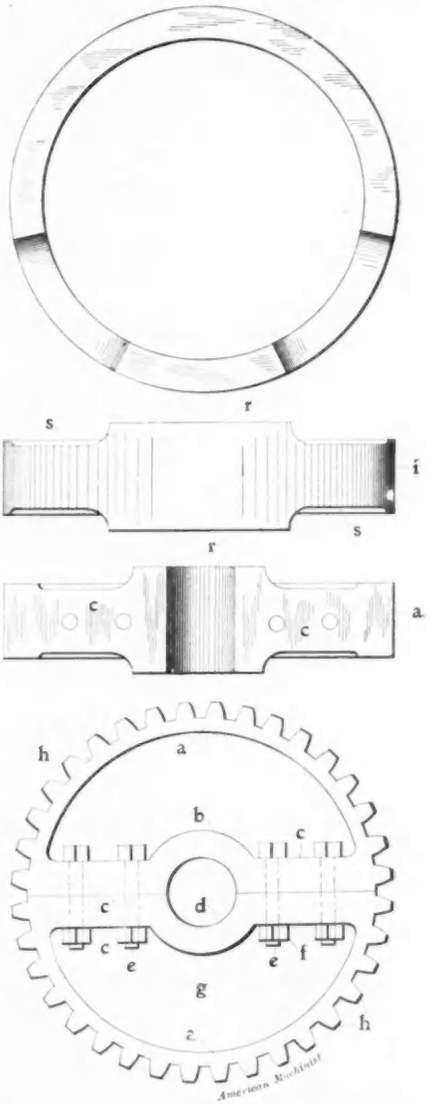
Pressed-Steel Gears.

An improvement in the manufacture of steel gears has been devised by Messrs. Ulrich and Fred. L. Eberhardt, of Newark, N. J. The gears are primarily designed for street car service, being made in halves for ready and easy clamping upon the axle or removal and renewal when necessary. Steel castings have been widely used for this purpose, but not with perfect success, and it can scarcely be doubted that the present gears will prove to be superior.



The blank for each half gear consists of a weldless steel ring, Fig. 1. Each ring is shaped by pressure in suitable dies, being flatted down upon one side, the hub being shaped at the same time, until the perfect shape for the half gear is secured.

The flat faces are planed, the halves are drilled and bolted together, and the gear is then bored and turned, and the teeth are cut in the usual way.

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Commercial Review.

NEW YORK, FRIDAY EVENING, APRIL 23.

STEAM POWER MACHINERY.

A strongly characteristic feature of the local engine and boiler market is the reluctance shown by prospective buyers to become such in fact. That there is no lack of inquiries, is conceded on all hands, and they are inquiries of a substantial nature, too, a leading boiler company informs us; but for some reason, or reasons, the projected contracts remain open.

To explain these matters satisfactorily seems to be beyond the power of man, every possible or impossible cause having been adduced long ago. Perhaps, however, the following, by one of the boiler fraternity, expresses the facts, if not the ultimate reasons, in as good a form as any: "My idea is, that it is the extra buying which makes good times. People buy groceries and dry goods year in and year out, but the active demand for machinery comes when investors are in a mood for speculating. In times like the present, they prefer to accept low rates of interest for their money, rather than to run risks."

The New York representative of a leading steam pump company says: "Business shows little change. Compared with what was expected, it is unsatisfactory. The reason is unaccountable. Last April we were rushed, now we are only busy."

It is stated that the Excelsior Power Company and New York Light, Heat and Power Company, not long ago passed into new hands, and will take out some old engines and put in fresh ones. The old ones consist of six Russell, one Ball & Wood and two Wright, and the new ones are to be two 1,000 horse-power engines adapted to direct-connected work. Here is a sizeable order to look out for.

Some extensive purchases have been made by the Staten Island Traction Company for their power plant at Livingston.

(*Continued on page 36.*)

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Business Specials.

Gear wheels, gear cutting. Grant; see page 16.

Forming Lathes. Mer. Mach. Tool Co., Meriden, Ct.

Engine Castings ⅛ to 2 H. P. Finished boilers and engines. Grant Sipp, Paterson, N. J.

Send $1 to the Tabor Mfg. Co., Elizabeth, N. J., for improved stop-motion revolution counter.

Selden Packing for stuffing box, with or without rubber core. Randolph Brandt, 38 Cortlandt st., N. Y.

Wants.

Situations and Help Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. The Cash and Copy should be sent to reach us not later than Saturday Morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Situations Wanted.

A mech. eng., grad. of a Ger. univ., wishes pos. as draft-man; mod. sal. Box 194, AM. MACH.

Mech. draftsman and designer, tech. grad., exper. machinist, wants pos. Box 189, AM. MACHINIST.

First-class stenog'h'r, exp. in mac'y work, des. to change. Ref. from present emp. Box 193, AM MACH.

Mill engineer wishes position; references and statement of past experience furnished. Address Box 191, AMERICAN MACHINIST.

Experienced mechanic and designer of machinery and tools desires position as superintendent or designer. Box 181, AMERICAN MACHINIST.

A mech eng'r, with wide experience on light machinery and tools, wants a Western position as superintendent. Box 187, AMERICAN MACHINIST.

All-round machinist and tool maker, experienced in modern methods and machinery, designing of special tools, wants position. Box 178, AM. MACH.

A party with a number of years' exp. in mfg. companies desires a situation as assistant to some mfg. co. Details and management of help pref. Ref. furn. Ad. M. W. C., P. O. Box 1829, Boston, Mass

Mech. eng'r, age 43, desires change June 1. Specialty: Invention of processes and mach'y for reduc. mfg. cost. Also exp in design and erection of power plants and elec. mach'ry. Box 190, AM. MACHINIST.

English Trade—Engineer and salesman (now in New York) well known in Great Britain, wishes to represent American mfr. of specialties in tools or machines; commiss. or salary. Box 166, AM. MACH.

Wanted—Posi. as supt. or designer by young man thoroughly familiar with all kinds of rubber working machinery. At present with one of oldest builders in U. S. Address Box 175, AM. MACHINIST.

Die Maker—A1 die and tool maker, well up in all modern improved dies for forging, stamping, drawing, blanking, etc.; also automatic and compound dies for all sheet metals as brass, iron, steel, aluminum, etc. Can design and develop ideas; 10 years' experience in best shops of Connecticut and Massachusetts. Best of ref. as to ability and character. Can accept second week of May. "Die Maker," AMERICAN MACHINIST.

Help Wanted.

Wanted—George H. McDonald to write to Caleb Miller, No. 1 Fenchurch Street, Norfolk, Va.

A thoroughly competent foreman on high-grade cyclometer work. Linden Mfg Co., 46 Lawrence Street, Newark, N. J.

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Miscellaneous Wants.

Advertisements will be inserted under this head at 30 cents per line, each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Cheap 2d h'd lathes & planers. S. M. York, Clev'd, O

Calipers & Gauges. F. A. Welles, Milwaukee, Wis.

The Dutton Wet Twist Drill Grinder is sold by the Garvin Machine Co., New York City.

For Sale—Otto 6 H. P. gas engine; excellent condition. Frank H. Chisholm, Bloomington, Ill.

Best and cheapest Bolt Header, made by Baush & Harris Machine Tool Co., Springfield, Mass.

Models, experimental and small special machy built. Write to Crocker & Lawson, Binghamton, N. Y.

Light and fine mach'y to order; models and elec trical work specialty. E. O. Chase, Newark, N. J

For Sale—Second-hand drill presses, engine lathes & planers. Dietz, Schumacher & Boye, Cincinnati, O

To Let—First and second floors 93 John Street. Space about 4,000 square feet. Rent $2,000. Apply Jessops, 91 John Street.

We make a specialty of Shartle's patent safety set collars. Prices low and samples free. Middletown Machine Co., Middletown, Ohio.

Wanted—Every reader of this paper to send 35 cents for The Tool Catalogue. See Montgomery's advertisement on page 36 of this edition.

Wanted—A machinist would like to hear of a growing town that is in want of a jobbing shop. Address Box 192, AMERICAN MACHINIST.

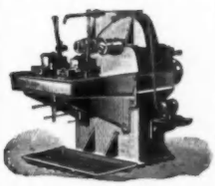
For Sale Cheap—1 late imp. Lodge & Shirley lathe; 18 in. x 10 ft., with tools and belting; good as new, good reasons for selling. Add. Box 188, AM. MACH.

Model Locomotives—Complete castings, latest N. Y. Cen. standard, up to date; 4c. in stamps for catalog. G. H. Olney, 163 Herkimer St., Brooklyn, N. Y.

Wanted—An Idea. Who can think of some simple thing to patent? Protect your ideas; they may bring you wealth. Write John Wedderburn & Co., Patent Attorneys, Washington, D. C., for their $1,800 prize offered to inventors.

Wanted—To correspond with parties having article of manufacture now made on contract which could be further developed under the favorable conditions we have to offer. Would also like to hear from firm open to change whereby an established bus. may be increased. Cheap power and low rents, or increased capital if investigation warrants. Confidential. Address, Board of Trade, care AM. MACH.

Machine shop wanted to contract for supplying air-brakes built to patterns like specimen standard machines furnished by advertisers. Only shops with modern machinery, including boring machine, need ans. Contractor must be able to turn out accurate work, promptly and in quantity. Shop must be near N. Y. and convenient for inspection of work. All transactions spot cash. Box 186, AMER. MACH.



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THREADING MACHINES.

Two Styles. Four Sizes.

Send for Catalogue "A."

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Cor. Spring and Monroe Sts.,

Springfield, Ohio.

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GAS, GASOLINE AND OIL ENGINES.

By GARDINER D. HISCOX, M. E.

A book designed for the general information of every one interested in this new and popular motive power, and its adaptation to the increasing demand for a cheap and easily managed motor requiring no licensed engineer.

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56 LIBERTY ST., NEW YORK.

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AND OTHER NEW CONVENIENCES.

SEND FOR CIRCULARS.

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NEW HAVEN, CONN.

The Bullock Electric Mfg. Co.

Formerly THE CARD ELECTRIC MOTOR & DYNAMO CO.

CINCINNATI, OHIO.

SLOW SPEED DIRECT CONNECTED MOTORS For Machine Tools and Line Shafts.

(Continued from page 35.)

S. I., including a 1,500 horse-power cross-compound E. P. Allis engine, a Cahall boiler of the Babcock & Wilcox type, and, we believe, an automatic stoker. The power station was laid out as a fine one, the walls being said to be forty inches thick at the base.

An example of the ruinously low prices which still prevail is found in the equipment of the above-mentioned plant, there having been purchased for it, also, two 400 horse-power engines, second hand, but nearly new, and of a most excellent make, for the aggregate price, it is reported, of $3,500. Speaking of prices, it is well understood that some boilers are selling below cost. And we are reliably informed that new 18-inch lathes have recently been sold as low as $210.

Some of the ripening contracts for engines, boilers, etc., to be used in local office and other buildings, have lately fallen into the baskets of fortune-favored companies. The Anson building, on John street, New York, of about fourteen stories in hight, has placed orders, including those for two Russell engines of 80 horse-power each, directly connected to Eddy dynamos. The Western Electric Company will do the remainder of the electrical work, and two water-tube boilers, of 150 horse-power each, will be supplied by a company having headquarters in New York. W. R. Fleming & Co., agents for the "Ideal" and "Ide" engines, report considerable local work during a few weeks past, they having sold four engines for the Hudson building, on lower Broadway, and two to the Manhattan Storage & Freezing Company; another order came from the Teachers' College. An installation of one of their engines in the Townsend building, on Broadway, near Twenty-fifth street, is just about completed, and subsequently an order has come from the St. James building, in close proximity. The Pierrepont Hotel, a house for bachelors' apartments, has given out a boiler contract, and later one for lighting engine and dynamo will doubtless be placed in some quarter.

The Abendroth & Root Manufacturing Company, boiler makers, report that they have just received a good-sized order for spiral tube water pipe to go to Toluca, Mexico, which has been figured upon since March 1st. In another quarter it is remarked that Mexican export trade is suffering from a rate of exchange at 205 per cent. A very prominent company manufacturing Corliss engines, etc., report good inquiry from Europe.

GREECE, TURKEY AND MACHINERY.

In view of the fact that the war in the East, thus far, has had only a moderately deleterious effect upon the stock market, it would seem that the machinery market is altogether too remote a subject to

(Continued on page 37.)

PATENT YOUR IDEAS!

The simplest ideas if properly patented will frequently yield large profits.

PHIL. T. DODGE, Patent Attorney.

U. S. and Foreign Patents. Trade-marks, etc.

LOAN AND TRUST BUILDING, WASHINGTON, D. C.

FOR ADVERTISEMENT OF
TIGHT JOINT CO. NEW YORK,
See Issue of April 1, 1897.

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in the City of New York.

SCHOOL OF MINES,
SCHOOL OF CHEMISTRY,
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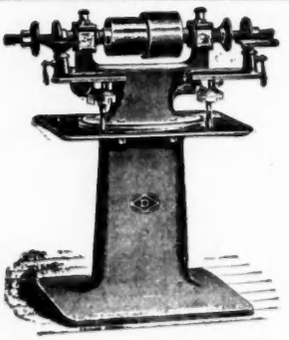
Our New and Revised Catalogue of Practical and Scientific Books, 88 pages, 8vo, and our other Catalogues and Circulars, the whole covering every branch of Science applied to the Arts, sent free and free of postage to any one in any part of the world who will furnish his address.

GRINDSTONES FOR MACHINE SHOPS.
WILSON MITCHELL, 310 N. 4th St., Phil., Pa.
Send for "Grinding instead of Planing."



GRINDING MACHINERY.

There are other Grinders on the market. Anybody can make one, and make a good one, if he puts work enough on it. But there never has been one made that would stand the test of hard wear like ours, because we make it on the right principle, cast-iron Engine Lathe Boxes, and a Dust Protector that protects. It is expensive construction, but our customers have used it for years and years, and like it. You will too. Write to us.

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London Agents, CHAS. CHURCHILL & CO., Limited.
Paris Agents, FENWICK FRERES.
Berlin Agents, SCHUCHARDT & SCHUTTE.
Copenhagen Agent, V. LOWENER.

J. M. ALLEN, President.
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Tool Catalogue

must necessarily be an adjunct to your workroom, library or den. The Tool Catalogue has 710 pages, over 4,000 illustrations, and describes, lists and discounts Tools and Shop Supplies. In two editions: cheap (linen) binding, at 35 cents, postpaid; handsome cloth binding, $1.00, express paid. Money paid for catalogue refunded with first order amounting to $10.00 or over.

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The Tool Dealers,
105 Fulton Street, New York City.

You will always get better results by specifying the purpose for which steel ordered is to be used. HAVE YOUR STEEL FITTED TO YOUR WORK. This is our specialty.

CRESCENT STEEL COMPANY, PITTSBURGH, PA. CHICAGO, ILL. NEW YORK, N. Y. DENVER, COL.

"THE WORLD'S BEST."
THE PANCOAST VENTILATOR.
HANDSOME, STRONG, DURABLE, EFFICIENT.
Leads them all in giving the best of Ventilation.
Houses, Mills, Factories, School-Houses, Churches, Refineries and *Founderies* use them with perfect results.
Architects in preparing plans for buildings should always specify the *Pancoast Ventilator.*
PANCOAST VENTILATOR CO., Inc., Manufacturers,
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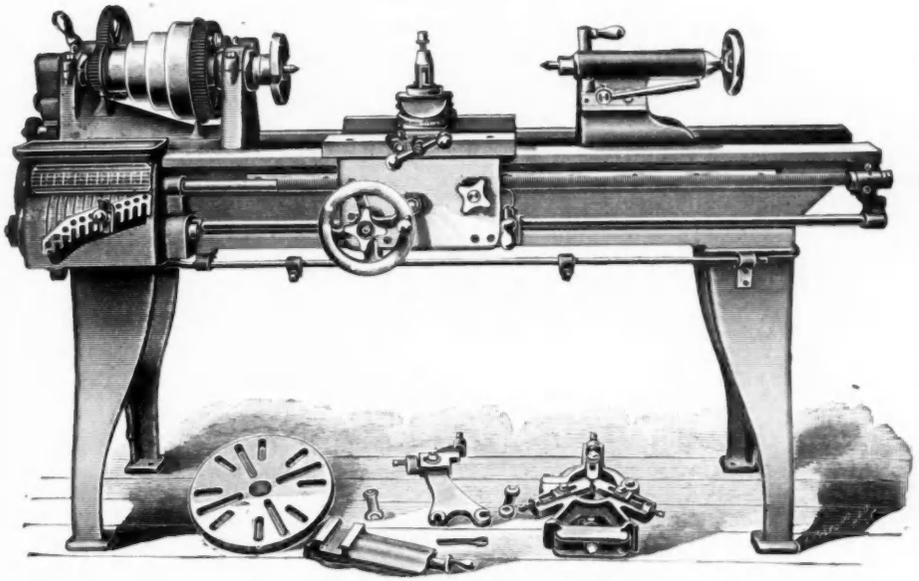
THIS LATHE COMBINES THE LATEST AND BEST IMPROVEMENTS.



14 in. x 6 ft. Hendey-Norton Lathe

With Improved Automatic Stop.

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AUTOMATIC STOP

It is durable, simple, indispensable. It will automatically stop the carriage in either direction. It is equally efficient whether feeding or thread-cutting, running up to a shoulder, boring to bottom of holes, or internal thread-cutting. No danger of spoiling either tool or work. It is a safeguard against accidents in either direction.

CARRIAGE

The carriage reverses in apron; no slamming of countershaft. There is no comparison between this lathe and the old style or common lathe.

THREADS

It has all threads in daily use with simple movement of lever.

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Has all feeds in daily use with simple movement of lever. Send for Circular.

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Agents for the Pacific Coast, PACIFIC TOOL AND SUPPLY CO., San Francisco, Cal.

European Agents, { CHAS. CHURCHILL & CO., Ltd., London and Birmingham. SCHUCHARDT & SCHÜTTE, Berlin and Vienna. EUGENE SOLLER, Basel, Switzerland.

(Continued from page 36.)

be affected by it to any appreciable degree, unless, indeed, in regard to a demand for war supplies. It is not unlikely that the war will come to too speedy a termination to allow very much business of this nature—that is, assuming the embroilment remains local; if it does not, as signs of unrest among the Balkan States indicate may be the case, the consequences are beyond prediction.

At present general commercial sentiments in respect to the war, including those of the steam-power machinery manufacturers, are comparatively apathetic.

Quotations.

NEW YORK, Saturday, April 24.

Iron—American pig, tidewater delivery:

No. 1 foundry, Northern	$11 75 @ $12 25
No. 2 foundry, Northern	11 00 @ 11 50
No. 2 plain, Northern	10 25 @ 10 50
Gray forge, Northern	10 00 @ 10 25
No. 1 foundry, Southern	10 75 @ 11 00
No. 2 foundry, Southern	10 25 @ 10 50
No. 3 foundry, Southern	10 00 @ 10 25
No. 1 soft, Southern	10 50 @ 10 75
No. 2 soft, Southern	10 25 @ 10 50
Foundry forge, or No. 4, Southern	9 50 @ 10 00

The change in quotations of Northern irons is owing to a reduction in freight.

Bar Iron—Base—Mill price, in carloads, on dock: Common, 1.00 @ 1.10c.; refined, 1.10 @ 1.25c. Store prices: Common, 1.25 @ 1.35c.; refined, 1.35 @ 1.50c.

Tool Steel—Ordinary sizes, standard quality, 6 @ 7c., with some brands perhaps a little less; extra grades, 11 @ 12c.; special grades, 16c. and upward.

Machinery Steel—Ordinary brands, from store, in small lots, 1.50 @ 1.60c.

Cold Rolled Steel Shafting—Base size, 2.50 @ 2.55c., in small lots, from store.

Copper—Carload lots, Lake Superior ingot, 11¼ @ 11½c.; electrolytic, 11 @ 11⅝c.; casting copper, 10½ @ 10¾c.

Pig Lead—In carload lots, 2.32½ @ 3.35c., f. o. b., New York.

Pig Tin—For 5 and 10-ton lots, 13.25 @ 13.35c., f. o. b.

Spelter—In carload lots, New York delivery, 4.10 @ 4.15c., f. o. b.

Antimony—Cookson's, 7¼ @ 7½c.; Hallett's, 7 @ 7⅛c.

Lard Oil—Prime city, present make, commercial quality, in wholesale lots, 38 @ 40c.

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New Catalogs.

There are three sizes of Standard Catalogs, first authorized by the Master Car Builders' Association, 9" x 12", 6" x 9" and 3½" x 6". We recommend the 6" x 9" size for machinery catalogs. When they must be larger or smaller, one of the other standard sizes should be adopted if possible.

The Swift Lubricator Company, of Elmira, N. Y., send us a catalog devoted to the illustration and description of lubricators, oil cups, safety valves, injectors, etc. The catalog is 5¾ x 8¾ inches.

The Ashcroft Manufacturing Company, 111 Liberty street, New York, send us a catalog devoted to the illustration and description of speed recorders, indicators, planimeters, etc. The catalog is 6¾ x 9¼ inches.

The Standard Gage & Manufacturing Company, Cleveland, O., have sent us a small catalog devoted to the description and illustration of the Standard safety water column. The catalog is standard size, 3½ x 6 inches.

We have received from the Dobbie Foundry & Machine Company, Niagara Falls, N. Y., catalog No. 5 of contractors' and quarrymen's machinery, including cranes, hoisting machines, derricks, wire rope, etc. The catalog is standard size, 6 x 9 inches.

We have received from Fenwick Freres & Co., Paris, France, agents for several American machine tool builders, catalogs printed in the French language. Among these are those of Norton Emery Wheel Company, Worcester,

Mass.; Brown & Sharpe Manufacturing Company, F. E. Reed Company, Worcester, Mass., and other well-known American machine builders. Those interested may obtain any or all of these upon application.

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Manufactures.

At Allentown, Pa., a new silk mill will be erected by Givernaud Bros.

The enlargement of the Mercur mill at Manning, Utah, is being pushed.

The Art Portland Cement Company, of Sandusky, O., will enlarge its plant.

H. A. Christy & Co. is the name of a new concern formed at Jackson, Mich.

J. B. & J. M. Cornell will enlarge the West Point Foundry at Cold Spring, N. Y.

The Acme Manufacturing Company, of Philadelphia, Pa., will add to their plant.

The Nixor Paper Company, Manayunk, Pa., contemplates the placing of new machinery.

The Monarch Portland Cement Company, Bronson, Mich., will erect a new factory building.

The Ohio Valley Pulley Works, Maysville, Ky., contemplate the addition of new machinery.

The Missouri, Kansas & Texas Railroad expect to erect new car-building shops at Sedalia, Mo.

The Forge & Bolt Company, of Chicago, Ill., has begun the construction of an addition to its works.

Messrs. Bartlett, Hayward & Co., of Baltimore, Md., contemplate the enlargement of their foundry.

The Eureka Gate Company, of Waterloo, Ia., has been incorporated, and a new plant will be erected.

At Velasco, Tex., the Velasco Mill Company has been organized. The incorporators are Jens. Moller, J. M. Moore and L. R. Ryan.

The Pintsch Compressing Company, of which Mr. P. St. Johns is general agent, contemplates the erection of a new plant at Jacksonville, Fla.

Eutaw, Ala., will erect water works. Plans and specifications can be had of Begrue & Alber, engineers and contractors, Birmingham.

It is probable a new factory will be commenced at Batavia, N. Y. Mr. L. M. Howe, of Indianapolis, Ind., may locate his plant there.

The Acton Iron Works, Birmingham, Ala., will enlarge their capacity and put in new machinery, such as lathes, shapers and planers.

The Hyatt Roller Bearing Company, of Newark, N. J., owing to increased business, will remove their factory and general offices to Harrison, N. J.

The Central Iron & Steel Company has been incorporated at Harrisburg, Pa. The directors are James McCormick, H. B. McCormick, William H. Wallace, etc.

Dietz, Schumacher & Boye, Cincinnati, O., are going to erect a new two-story machine tool building, 180 x 90 feet. Work on this will be commenced as soon as possible.

At Poulan, Ga., the Aberdeen mill will soon be erected. The capital stock is $100,000, and Messrs. J. Howard Bromley, of Philadelphia, Pa., and H. H. Negley, of Pittsburg, Pa., are interested.

J. S. McIntosh, formerly foreman of the Marriot Machine works, Birmingham, Ala., has leased the old Alabama Iron Works, and will put in a complete outfit of new machinery, suitable for repair and job shops.

The Pratt & Whitney Co. HARTFORD, CONN., U.S.A.

...MAKERS OF...

Fine Machine Tools.

Complete Plants furnished for Bicycle, Typewriter, Gun and Sewing Machine Makers. Gauges and Small Tools for all Machine Work. Drop Hammers and Trimming Presses. Forging and Trimming Dies for all classes of work.

England—BUCK & HICKMAN, 280 Whitechapel Road, London, E. *Chicago*—42 and 44 South Clinton Street.
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SHELL AND SOLID REAMERS,

WITH PAT. SPIRAL FLUTES.

Arbors, Mandrels, Taps, Dies, Screw Plates, Tap Wrenches, Bolt Cutters, Drilling Machines, Etc.

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All these are comprised in the make-up of our lathes and are the four necessary points in the construction of a good tool. Add to these a FIFTH and a very important one, the price, which we make very low to prompt cash buyers, and you have the story. Our Catalogue will tell you all about our Lathes, Planers, Shapers, etc.

SEBASTIAN LATHE COMPANY,
117 and 119 Culvert Street, CINCINNATI, OHIO, U.S.A.

DYER & DRISCOLL,
PATENT SOLICITORS, 36 WALL ST., N.Y.

Have done all my patent soliciting work, both for this and foreign countries continously for the past fourteen years.

Thomas A. Edison

STAR LATHES

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Foot Power Screw Cutting, Automatic Cross Feed, 9 and 12" Swing.

Send for Catalog B.

Seneca Falls Mfg. Co.
687 Water St., Seneca Falls, N.Y.

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that have Trade Mark same as cut, they are all right for high pressure steam. All others are imitations and you cannot hold us responsible. If you cannot get our discs from your dealer, send to us for them.

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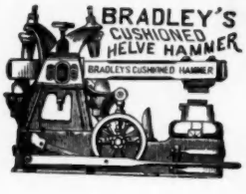

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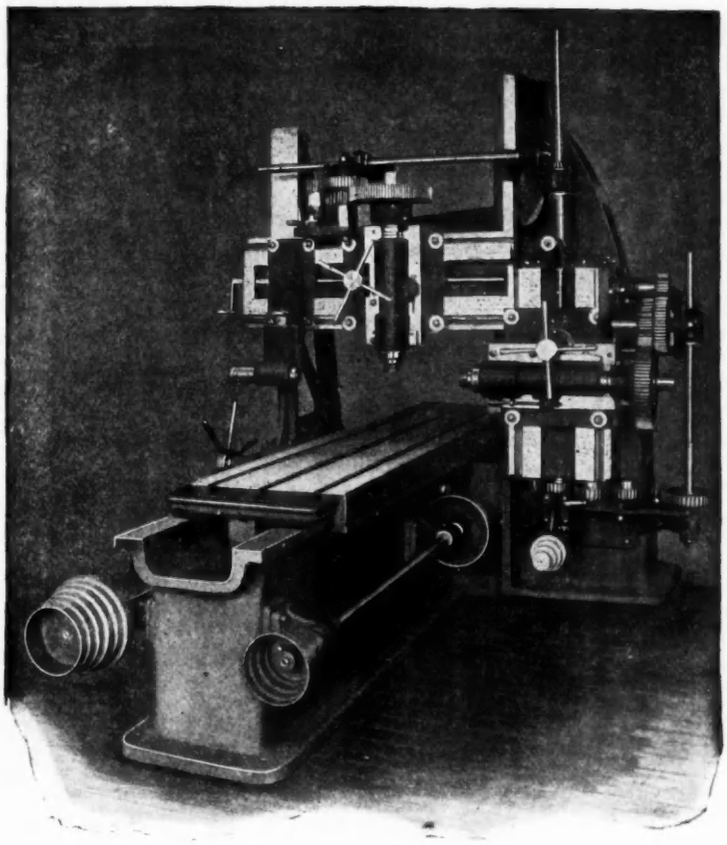

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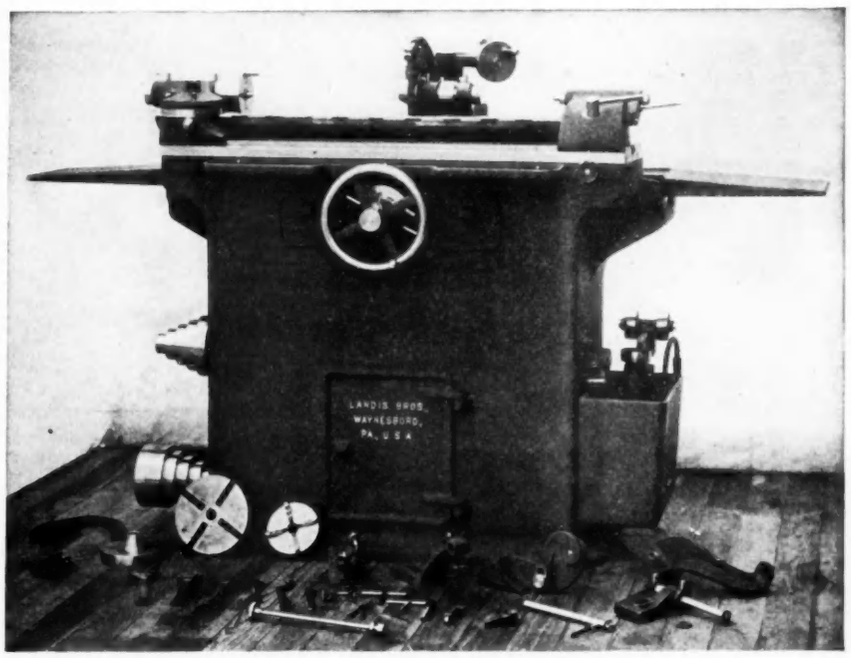

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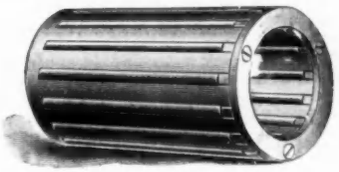

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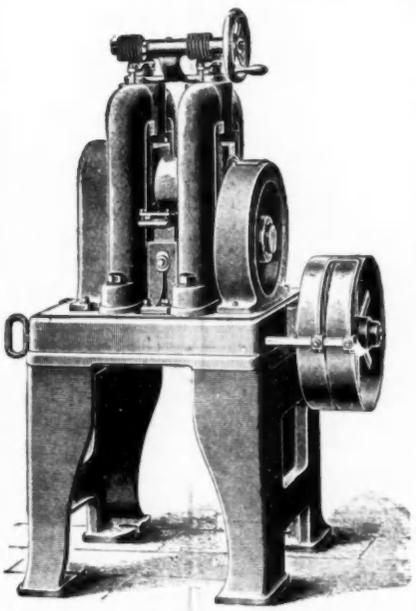

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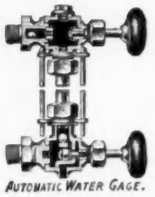
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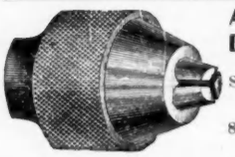
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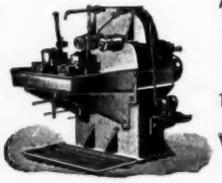
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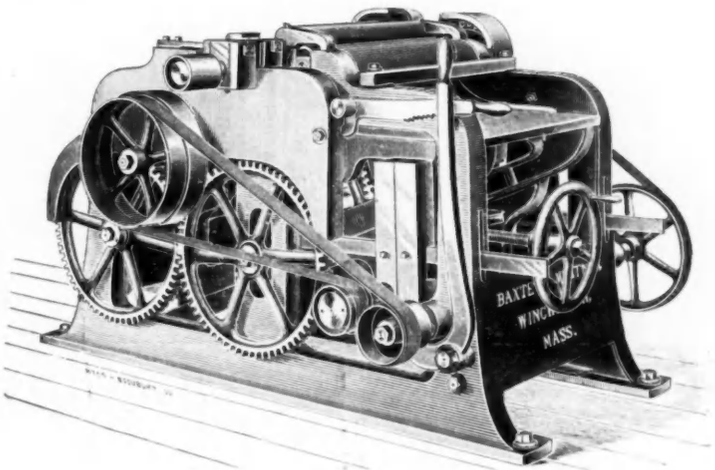
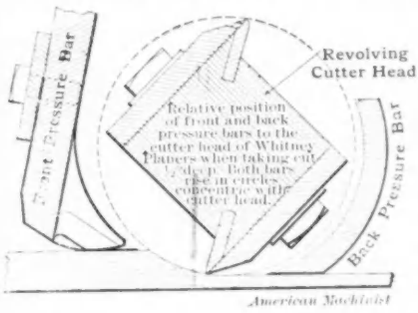


Anent Pressure Bars.

They are made so as to give to the inequalities of the lumber in all directions. The Bars are placed one at each side of cutter head, and by their peculiarities of construction, press on the work at the nearest possible point to the edge of the cutter; the relative positions of the pressure bars and cutters always remaining constant regardless of the thickness of stuff, or amount of cut.


Front Pressure Bar
Revolving Cutter Head
Relative position of front and back pressure bars to the cutter head of Whitney Planers when taking cut 1/4" up. Both bars rise in circles concentric with cutter head.
Back Pressure Bar
American Machinist

ped has the important A machine thus equip-
stuff less than 3" long advantage of planing
ends. The front pres without clipping the
have a flexible spring sure bar will be seen to
back toward the cutter under it which extends
of motion of the latter. and very close to the line
send a sample of the We should be pleased to
planer. Another feature work put forth by this
the cutter head. This is of this planer is found in
steel, having a more sat made from the best tool
greater rigidity than the isfactory temper and
entering into the mak cheaper steel ordinarily
detail of a planer, and in consequence of the attention bestowed upon it the liability of deformation and consequent heating is practically an unknown quantity.

•• P4 ••

The treatment in a manner comprehensive of the many meritorious features attendant on this planer is utterly impossible in the limited space here commanded. The whole* story told at length, comes to you on request.

•• P4 ••

Baxter D. Whitney, Winchendon, Mass.

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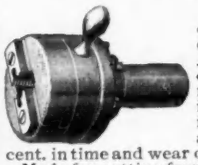

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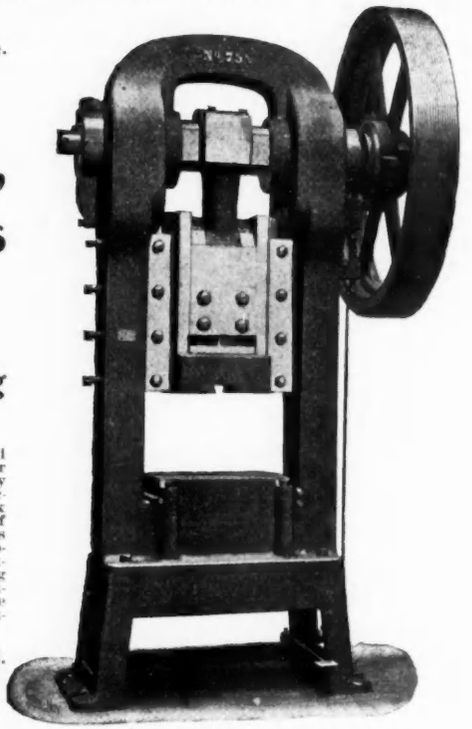

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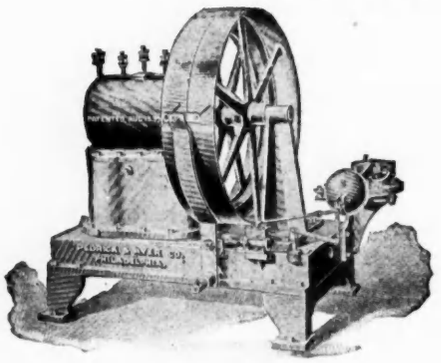

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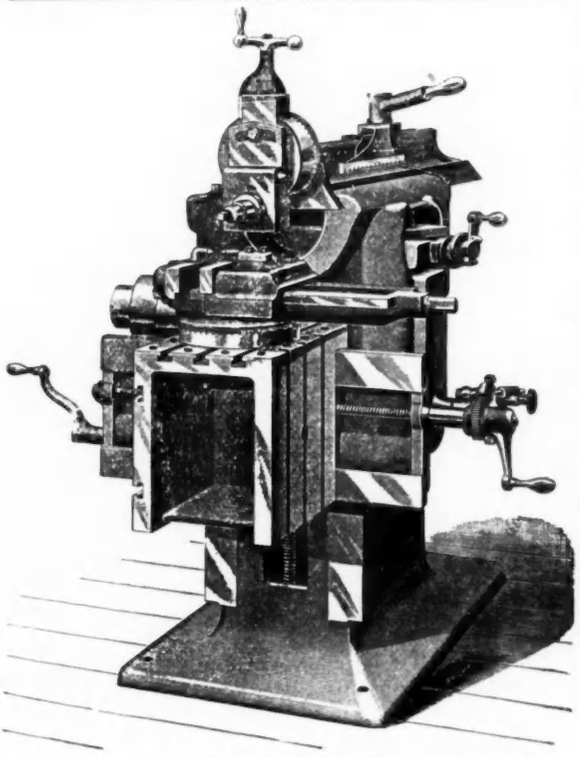

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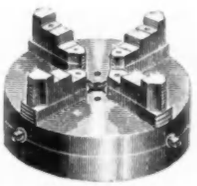

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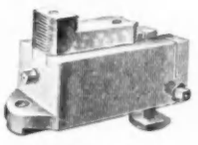

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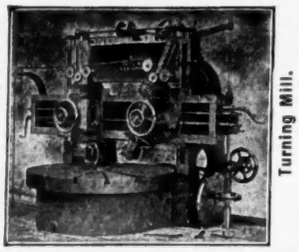

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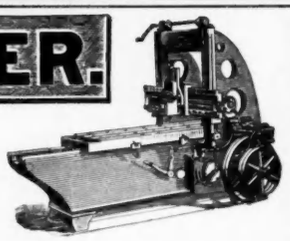

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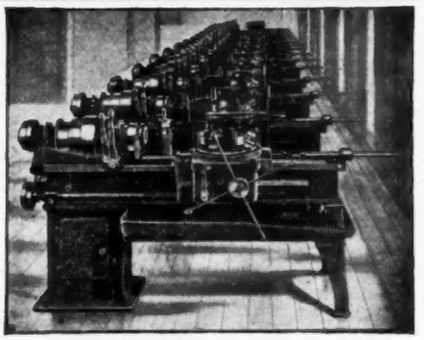

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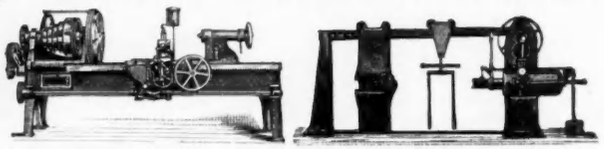

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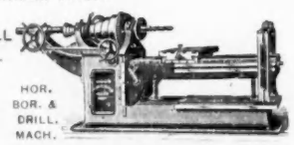

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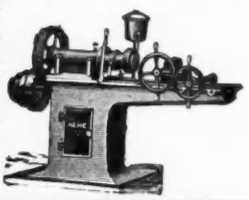

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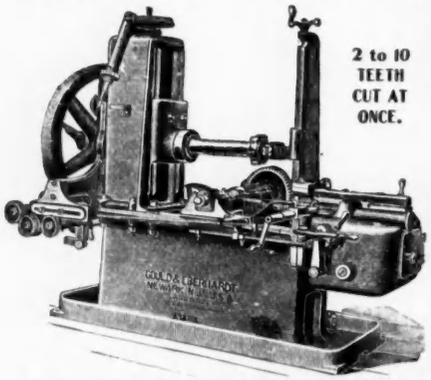

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